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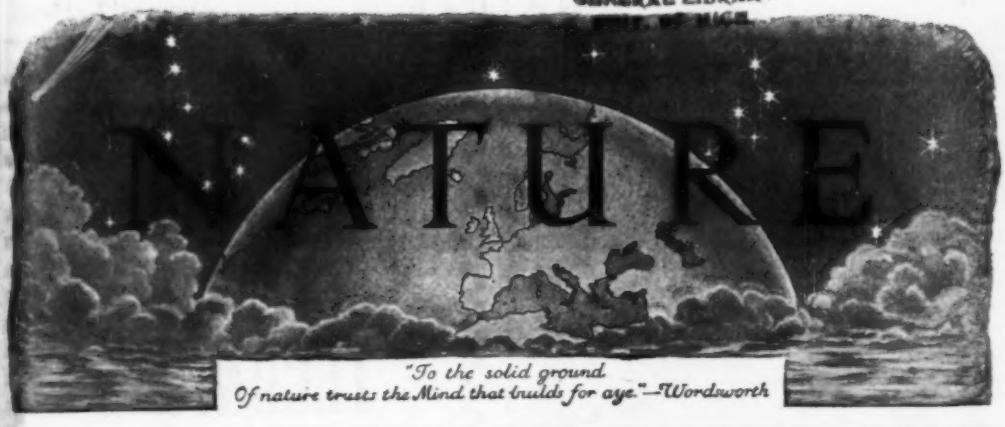

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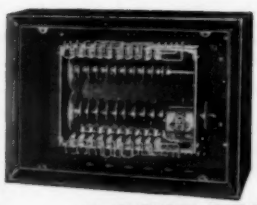

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RESEARCH IN THE TEXTILE INDUSTRIES

THE Cotton Board Committee to Enquire into Post-war Problems, under Sir Raymond Streat as chairman, reporting to the President of the Board of Trade in January 1944, gave close attention to research, and urged that the aim of the industry must be to equal and, if possible, surpass the achievements of all rival textile industries. It recognized that, although the Government could do much to encourage research, the outlook and actions of those concerned in the industry would dictate the ultimate results in this field, and that the employment in development of men of real scientific attainments would be a factor of special importance in the period of exceptional technical development which the Committee anticipated. The post-war Cotton Board should, in the opinion of the Committee, do everything in its power to further research and to assist every unit in the industry to secure the fullest access to its fruits.

The Cotton Board Committee appended to its report a memorandum on scientific and technical research, in which it reviewed the growth of research in the industry during the last twenty-five years and the present position of the industry's research association as well as the needs of the future. The Committee in this memorandum emphasized the profound importance to the future of the industry of the fundamental scientific research work of the Shirley Institute, and expressed the emphatic opinion that the Institute should continue to interest itself in all fibres likely to be of use to the Lancashire industry. Tribute was also paid to the liaison work and training scheme of the Institute, and hope was expressed that the highest possible degree of priority would be given to the intensification of these activities in the reconstruction period. Thorough investigation of problems connected with consumer research by a suitably constituted committee of the industry was also recommended.

Neither these recommendations and the memorandum embodying them, nor the accompanying memorandum on economic research and information, appear to have received the attention from the cotton industry or from scientific workers themselves that was hoped. Nevertheless, it is clear that the chapter on science and industrial progress in the report of the Cotton Working Party* owes much to this earlier memorandum, although the recommendation relating to market research passes over the suggestion in the previous memorandum regarding the need for statutory powers to collect information, and authority for the post-war Cotton Board to spend a reasonable sum on economic research and in collecting and circulating information. This chapter and the ensuing recommendations, however, have claims on the attention of industry and of scientific workers generally. Much of the soundest opinion expressed in the discussion on scientific and industrial research is reflected in this report; it avoids platitudes, and outlines a pro-

* Board of Trade. Working Party Reports: Cotton. Pp. vi+278. (London: H.M. Stationery Office, 1946.) 3s. 6d. net.

gramme which British industry generally and also the universities would do well to mark.

Much would indeed be expected from the Research Sub-Committee, which included Mr. J. Baddiley, Prof. Willis Jackson and Prof. W. E. Morton, on whose reports and data the Working Party based its findings. It is unfortunate that this valuable section of the report—an outstanding contribution to the development of industrial research—should have been so overshadowed by the more controversial sections as to pass virtually unnoticed by the scientific and technical Press. This lucid exposition of the relations between industry and science indeed well merits issue as a separate document; moreover, unlike other sections of the report, it is endorsed without reservations by the whole Working Party.

Research is classified into three types: fundamental research, or the pursuit of knowledge for its own sake; operational research, or the use of scientific method in the study of practical industrial problems; and applied research, or the application of scientific knowledge to the improvement of industrial production or practice. Only the first and third of these are regarded as covering activities generally understood as scientific research. Operational research may involve activities of an entirely different nature, such as market research and labour research, or investigations in the wide field represented by the expression 'industrial relations'. Elsewhere, the Working Party recommends that a programme of research on matters affecting industrial employment should be worked out by the central body for the industry, and emphasized the need for scientific study in questions affecting the human factor. Apart from this, however, operational research and applied scientific research often overlap, and no hard-and-fast line can be drawn, so that some of these activities can appropriately be handled by an organisation set up to deal with scientific research.

Reviewing next the characteristics and conditions of the cotton industry, the report points out that, apart from the unification of outlook on the textile fibres resulting from recent fundamental research, the development of synthetic fibres has had important reactions on the industrial position. The spinners and weavers are in effect being sandwiched between an essentially chemical industry at one end making the raw material, and at the other end a chemical industry making the finishing materials. There is evidence that these scientific industries will not be content to accept the traditional methods of spinning and weaving, and, still more important, they are concerned with the whole field of textile industry. The four separate textile industries of the past—cotton, wool, flax and silk—must, if they are to be progressive, make use of the new fibres and introduce spinning and weaving materials adapted to it. To a large extent the new problems arising will be common to all four and the new knowledge will cut across all their dividing lines.

From this introductory survey the Working Party stresses some important points which apply to other industries as well as the textile industries. The need for a widely interpreted reciprocal relation between industry and science, and the importance of having sufficient men of high ability to carry out the necessary scientific investigations, have been emphasized in more than one report in the last few years. Less frequently, however, has it been recognized that science cannot make its true contribution to industrial progress unless research workers create an organised body of knowledge relating scientific theory with industrial practice, and unless industry, on its side, has enough men on the administrative side capable of understanding scientific principles. These are, however, two of the main factors which should determine the strategy of research, and the points made more particularly regarding the critical nature of the present moment for the textile industry and the great opportunity before it serve to underline their importance.

The admirable summary of the extent and scope of research work within the cotton textile industry both at the present time and during the last twenty-five years is of exceptional interest to the scientific worker. Moreover, it is noted that many of the developments are international in character, coming from scientific workers in many countries. While the share of British men of science in the past has been a notable one, the Working Party considers that in view of the rapid increase in scientific research and in higher education throughout the world, special efforts are now required to encourage and foster research activities in Britain to enable the country to maintain its position in the face of the intense industrial competition now to be expected. In particular, the Working Party endorses the view of the British Rayon Federation that the existence of a central rayon research institute in no way absolves individual firms from maintaining their own internal research organisations, which, on the contrary, it should supplement. This view is urged as equally applicable to the cotton industry, and in particular the Working Party considers that the textile machinery makers need to increase the scope of their research activities.

That is only one point on which the Working Party is highly critical of the industry. Urging the closest possible collaboration between the textile machinery industry and the centres of fundamental research, it points out that the textile machinery industry must not sit passively waiting for ideas on the physical properties of fibres to be passed on to it by the fundamental research centres. It should have a contribution of its own to make, and above all should employ a sufficient number of able physicists competent to understand the significance of fundamental discoveries and ensure that they are utilized and developed. It is noted that there are firms still hostile to the idea that higher education in general and higher scientific education in particular are of value in business. Apart from the finishing section of the industry, where the day-to-day operations are more nearly scientific than technological, research within the industry appears, with notable exceptions, to be directed mainly towards the refinement and

improvement of existing machines and processes, rather than to discovery or invention of fundamentally different ones.

The Working Party's observations on long-distance prospects of the technical development as well as on the liaison between centres of research activity also deserve consideration, both outside and within the cotton industry. The comment that the development of new fibres has possibilities which require the intensive and constant attention of the designers of textile machinery is obviously of interest chiefly to the textile industries; but the observation that liaison between the various research groups in the cotton textile industry could be very materially aided by the professional and scientific organisations, such as the Textile Institute and the Society of Dyers and Colourists, has wide implications for industry generally as well as for the scientific societies. The Working Party considers that the work of these two societies should be encouraged and assisted by the cotton industry, while it hopes that the Manchester Joint Research Council may also provide real assistance to the industry and that its facilities will be utilized to the full, along with those of the professional institutions and scientific societies, particularly in making surveys and reviews of textile knowledge and in organising conferences on textile problems from which suggestions for further investigations may come. Incidentally, it should be noted that in connexion with the employment in the industry of more people with a scientific training and outlook and improving the quality of the personnel in marketing, Prof. Jewkes refers to the great shortage of good text-books on textile matters, and suggests that the possibility of financing the production of these is worth the attention of the Cotton Board.

Thus far the report has considered the effective functioning of the trade research associations and the research activities of individual firms, incidentally paying a very high tribute to the work of past and present men of science in the laboratories of some firms. It then turns to consider the functioning of a further main instrument of research—the universities and technical colleges. Here the Working Party proceeds to press the argument for university expansion. Every endeavour should be made to enable the universities to train a larger number of students, and it has endeavoured to make some estimates of the industry's requirements of graduates both in textile technology and in pure science over the next five years.

While, however, the Working Party recognizes clearly the twin functions of the universities of giving training in fundamental science and of carrying out unfettered academic research, it does not look to the universities merely to train in research methods the men who will later on occupy research posts in industry. It is concerned at the tendency of firms which recruit scientific workers to regard them merely as experts who are to be confined to rendering a limited subsidiary service. That view has been repeatedly repudiated in recent authoritative reports, and the Working Party is emphatic that the cotton industry will not appreciate the value of scientific method or realize the commercial value of new scientific ideas if all trained scientific employees are confined to this role; and like the Cambridge University Appointments Board Committee on University Education and Business it points to the adverse effect on the attractiveness of a scientific career of such a limited conception.

The conclusions of the report in regard to the supply of qualified men merit careful attention in the formulation of plans for university expansion. The cotton textile industry, it is held, should encourage and assist financially and otherwise the maintenance, in universities and other teaching institutions of university rank, of strong and active research schools dealing with textile science and technology and the fundamental scientific background of the textile industries. As examples of the importance of scientific research in British universities to the industry, the report cites the work carried out on the structure of carbohydrates, which has revolutionized our knowledge of the structure of the fundamental materials used in the cotton industry and in other industries, and the fundamental scientific investigations on materials of interest to the cotton and rayon industry at present being developed in the laboratories of the University of Manchester for open publication. The Working Party is of the opinion that a strong school of textile technology and textile science should be maintained in Manchester, and that it should be assisted and encouraged in every possible way to undertake both the training of graduates and the carrying out of fundamental research in the various branches of textile science.

Important as is this contribution of the universities in fundamental research, and desirable as it is that firms in the industry should be given every encouragement to make contacts with the research schools for their mutual benefit, the Working Party emphasizes very strongly the need for the universities to maintain complete freedom as to the scope and direction of such fundamental research in their laboratories. Unless such work is spontaneous and unfettered, and its results open for full and free discussion, the progress of scientific discovery will be retarded and hindered. The value of personal contacts for discussion and exchange of information is again emphasized here, as in relation to the scientific and professional societies. The Working Party and its research sub-committee have clearly recognized the value of free dissemination of information in stimulating ideas and promoting the advance of industry as well as of science. Once again we find a policy of encouraging publication advocated, and the establishment of industrial research fellowships and associateships is suggested, a plan for which is sketched in the final recommendations. On the other hand, the Working Party is on much more dubious ground, and at issue with the Barlow Report on Scientific Man-power and the latest statement of the Ministry of Labour regarding military service, in suggesting that genuine training within the universities in textile science and related branches of pure science should be

regarded as a form of national service. If restrictions are to be relaxed and exceptions made to a general policy, it must be on national grounds and not for the advantage of a particular industry, no matter how important.

In view of the unification of textile science resulting from scientific progress during the last twenty-five years, it is considered that a co-ordinating body is required such as a Textile Advisory Research Council, covering the entire field of textiles, which could act in an advisory capacity to review, expand and co-ordinate research and development throughout the textile industries. Detailed proposals for the aims, functions and composition of such a council are appended to the report, and represent a contribution to the formulation of the broad strategy of textile research in Britain which is worth consideration as a general principle as well as from the particular point of view of the textile industries.

Such an advisory council, the Working Party suggests, would facilitate the correlation between the work of the central research institutions and the work of individual firms. The precise nature and scope of the functions of the research associations, how they can best be exercised, by what means their functions can be made of the fullest possible value to the industry, and how they should be correlated with the work of the research departments of individual firms are questions which confront research associations in all industries, and the Working Party does not think that the right answers to these questions are yet clear. It suggests that a review of the experience of the whole of the research associations in Britain would be useful.

As in other industries, there is clear need for better, and in particular speedier, methods of translating research results to large-scale production, and the greatest immediate practical need for British industry is to secure more effective application of scientific knowledge in industrial practice. Many of the proposals already noted are directed to that end, and in particular the increase of the proportion of men with good scientific training in the employment of industry. Only when the industry learns to use such men rightly, and when they are distributed sufficiently widely through the industry, can the dissemination of information by publication or by conferences, for example, be fully effective. Such conferences might be arranged for different classes of people at different times, for example, for directors, managers and foremen; and the Working Party suggests that a higher degree of integration or grouping together of the smaller firms may also assist in the absorption in the industry of more graduates in science.

The major interest of the report to the scientific worker is this outline of research strategy, set forth in a manner which, while applied in the first instance to the cotton and textile industries, is such that, quite apart from the general validity of its principles, it could easily be integrated with the general research structure and policy of Great Britain. It will be noted, moreover, that the Working Party avoided entering on a debate as to the extent to which research can be planned; this may be attributed to the clear conception of objectives and to the discrimination between different broad types of research.

While the particular section of the report we have been considering is concerned with scientific research in the limited sense already indicated, other sections of the report contain recommendations for research in other fields. For example, the need for scientific study in the field of human relations is emphasized. In this connexion the Working Party is concerned not only with research on matters affecting the physical health of the workers but also with the scientific study of conditions affecting the work-load involved in various processes, psychological factors, etc. It considers that a special intensive programme of study under these headings should be worked out by the central body for the industry. Again, in regard to market research, it points out that if this is to be valuable it cannot be conducted in a piecemeal or desultory way. The surveys involved require skilled personnel and must be undertaken continuously and on a broad basis. There is a great shortage of personnel with the requisite training. Substantial expenditure will be required to build up a staff and conduct work on an adequate scale, and there must be determination to go through with the task even if it does not show any immediate return. The Working Party recommends that the sum of about £350,000 now held by the Board of Trade, representing the unexpended balance of funds raised by levies in the first period of the operation of British Overseas Cotton Ltd., should be used to finance a programme of market research specially directed to the development of export markets.

Though there is much in the report of only indirect interest to scientific workers as such, it should be clear from what has already been noted that the report is addressed to the attention of many far outside the cotton industry itself. It is not merely that the Working Party considers that the integrating force which scientific advance has created for all the textile industries necessitates a new outlook on the relations between them; and accordingly it recommends that the Government should call an early conference between representatives of the rayon industry and all the textile industries to consider their future relations. Equally, in view of the importance of relating knowledge gained from research into potential market outlets with the industry's productive capacity, it suggests that special arrangements should now be made for organised consultation between the producing sections and those who have a close knowledge of consumer requirements, including large consuming institutions and representatives of scientific organisations such as the Shirley Institute, the proposed British Rayon Research Association, the British Standards Institution and the British Launderers' Research Association.

The organisation of such systematic conferences would do more than build up a body of knowledge and a method of co-operation which can be of the greatest value to the industry. It would equally facilitate a much wider understanding of the problems

of the cotton industry and of the textile industries generally, and encourage the contacts which might accelerate the breakdown of some of the older prejudices of the industry and encourage the wider use of trained men of science and a more scientific outlook at all levels. The report does indeed glance at the question of training for management, and in a section under that heading, besides recommending the long-term policy already noted of making special efforts to bring in, on the management side, men with high scientific or technical qualifications, it suggests that a larger proportion of young men is required in leading positions, and that it would be advantageous to bring in men with experience of modern methods as developed in other British industries.

The Platt Mission's recommendation that more facilities should be given for young men undergoing full-time college training in textiles to spend their vacations in mills is endorsed in this section of the report, where it is also recognized that more systematic arrangements are required for training in the principles of management and for broadening the outlook on administrative problems of those holding positions of responsibility. But while the Working Party welcomes the Government promise of support for a British Institute of Management, which it believes would be of value to the industry and should claim the support of the cotton industry, the suggestion that Lancashire should promote its own staff college is, to say the least, dubious. Leaving out of account the mere technical aspects of operating and organising of the industry, on which the Working Party itself is divided, the section on scientific and industrial progress to which all its members have subscribed constitutes a grave indictment of a large section of the industry, which is not disguised by the moderation of the report or its well-deserved tributes to the past achievements of individual British men of science and firms. Whatever may be the causes for this neglect and failure in the past, one factor, as the Working Party recognizes, is the isolation from which the cotton industry has generally suffered. What is needed now is to bring together men and women of executive responsibility from industry and commerce, the trade unions and central and local government, to study the common principles that underlie effective administration. To limit such a movement to Lancashire and to the cotton industry only would be to lose an invaluable opportunity to which this report directs attention anew. On the merits of many of the proposals of the report it is not for the man of science as such to pronounce. He can at least recognize the value of the contribution to the development of an adequate strategy and theory of research to be found in this report, endorse the appeal of the Working Party for the impartial study by the many interests concerned of this appreciation of the problems, and play his own part in urging the education and co-operation which are essential. Both are imperative to place this great industry on a basis which will enable it to utilize to the full the great opportunities which scientific and technical advances have already brought to its door.

CANCER RESEARCH IN THE UNITED STATES

A.A.A.S. Research Conference on Cancer

A Conference of Papers and Discussions presented at the Summer Meeting of the Section on Chemistry of the American Association for the Advancement of Science at Gibson Island, Maryland, July 31–August 4, 1944. Edited by Forest Ray Moulton. Pp. x + 333. (Washington, D.C.: American Association for the Advancement of Science, 1945.)

LIKE other peaceful pursuits of science, cancer research has probably been less interrupted during the war years in the United States than in Europe, and the publication of the papers and discussions at the American Association for the Advancement of Science Research Conference on Cancer held in 1944 is particularly valuable to non-American readers as "A landmark that records in some measure the status of cancer research in 1944", to quote from the introductory remarks of the chairman of the Conference, Dr. Dean Burk. In fact, the contents do seem almost fully up to date, partly no doubt because post-conference amendments and additions have been permitted to the participants. A judicious combination of this privilege with verbatim reporting by the new stenotypic method has resulted in a lively and informal record, especially in the discussions of the various papers presented, and the volume is a worthy successor to the earlier publication of the Association —"Some Fundamental Aspects of the Cancer Problem", which appeared in 1936.

Although inaugurated by the Chemical Section of the Association, the scope is wide, not restricted to chemical aspects but covering also almost the whole field of laboratory cancer research. The virus approach, carcinogenesis, enzymes, diet, and chemotherapy, form the main sub-divisions, each of which contains at least one first-class contribution, and often many more. For example, the 106 pages on the virus aspects, still perhaps the most controversial and provocative corner of the cancer field, contain a full introductory review by F. Duran-Reynals and W. Shrigley, of Yale, in which after dealing with the historical associations, the authors frankly "review certain facts that we know about cancer and . . . show that the properties of viruses and virus infections fit these facts very well". As would be expected, these views have their supporters and opposers in the ensuing discussion; L. C. Strong considers as a geneticist that the inexhaustible capabilities of cell differentiation reduce the cancer problem to the rank of a very minor biological matter, while the virus concept "entirely shoves aside" the whole field of embryology and differentiation. M. B. Shimkin is also critical of the wide extrapolation of observations made on the relatively few virus-induced tumours to the whole range of cancer, including that occurring in species in which no such viruses have been demonstrated as the causative agent; cancer may rather be "the end product of multiple etiological agents and multiple chains of reactions all leading to a somewhat similar terminal stage". A. Taylor and his colleagues believe that they have shown the presence of "extracellular tumour agent", as they call the "virus", in mammary cancer of mice by growing the tissue in yolk sac of hens' eggs and preparing from the eggs Berkefeld filtrates and dried material which have given malignant tumours when injected into mice. These results, like others from cultures of mouse

tumours in the anterior chamber of rat's eye, are evidently not yet accepted as proved by many of the participants, who ask for much clearer proof that such extracts were really cell-free; negative results with similar material are reported by W. R. Bryan, H. Kahler and V. T. Riley as the outcome of a careful study. They found no evidence of the presence of a rapidly acting virus-like principle associated with the Jensen rat sarcoma, the S37 mouse sarcoma, or the Taylor mammary gland carcinoma.

About half the section on viruses is devoted to the mammary tumour inciter which was first shown by Bittner in 1936 to be present in the milk of mice, and to produce, in an otherwise suitable strain of mice, a greatly increased incidence of mammary cancer. Few will quarrel with M. B. Shimkin and H. B. Andervont's statement that this discovery "represents probably the most significant advance in cancer research during the past decade". It is therefore a particularly valuable feature of this book that it includes a masterly review of 38 pp. by J. J. Bittner and important contributions by Shimkin and Andervont to this subject. At the present time three inciting influences are recognized in the etiology of spontaneous mammary cancer in mice: the inherited susceptibility, the hormonal stimulation, and the agent transferred in the mother's milk. The last is present in the first milk and throughout the period of lactation. It has been recovered from lactating mammary tissue, spleen and thymus, heart and lung, spontaneous mammary carcinoma, mammary cancer which had been transplanted for ten passages in mice not possessing the milk agent, and it may be present in the blood either within the blood cells or adsorbed on to them. The agent may be transferred by injection or feeding; it remains active after desiccation, filtration through Berkefeld or Seitz filters, lyophilization, or treatment with glycerol, petroleum or acetone. Its activity is destroyed by exposure to 60° or by acidity below *p*H 4·5; between *p*H 5 and 10·2 it is stable at ordinary temperature. It appears likely that in order that mice will develop 'spontaneous' tumours they must be exposed to the agent before their mammary glands have developed; but although mice so treated may themselves remain non-cancerous, they may transfer the active agent to their progeny, which may then show a high incidence of spontaneous mammary cancer. It is not yet known whether a similar agent is present in any species other than the mouse, including humans, and some evidence seems to oppose the view that it is. Apparently the rabbit can produce an antibody to the milk factor (M. B. Shimkin), and confirmation of this is forthcoming in papers published since the Conference (R. G. Green; R. G. Green, M. M. Moosey and J. J. Bittner, *Proc. Soc. Exp. Biol. Med.*, **61**, 113; 115; 1946). Ultracentrifugal studies suggest that a particulate material of sedimentation velocity about 60 S, containing ribonucleoprotein, may be the agent or contain it. The book provides an admirable account of these striking advances up to 1944.

An interesting question arises in the relationship of the milk factor to chemical and other carcinogens. Methylcholanthrene has been found to induce mammary cancer in strains devoid of the milk factor (M. B. Shimkin and H. B. Andervont, this volume p. 103; see also A. Kirschbaum, W. L. Williams and J. J. Bittner, *Cancer Res.*, **6**, 354; 1946). Stimulation by œstrogens, which itself does not result in cancer in absence of either the milk agent or the carcinogen, seems to be a necessary concomitant for carcinogenesis of this kind. Thus to some extent the chemical carcinogen can supplant the milk factor, an observation that opens up an attractive field for future investigations. L. F. Fieser, in a brief but stimulating article, reviews hydrocarbon carcinogenesis from the point of view of the organic chemist. Other valuable articles include several on leucæmia, on the production of malignancy *in vitro*, and of enzymes in normal and neoplastic tissues; in fact the book as a whole will be found to be a highly readable and informative account of current trends in cancer research in the United States.

There are those who affect to view such symposia as this as superfluous, on the grounds that they are mainly either recapitulations of work already published, or premature anticipations of that not yet ready to appear in public; but probably the majority will, like the reviewer, be grateful for the saving of time and effort afforded, especially now when our libraries have not yet fully recovered from direct and indirect effects of war.

F. DICKENS

A TEXT-BOOK OF GLACIOLOGY

Gletscherkunde

Von Dr. E. von Drygalski und Dr. F. Machatschek. Pp. 250. (Vienna: Franz Dentike, 1942.)

IF only on account of its rarity, the publication of a text-book of glaciology is an event worth noting, especially when the book bears the name of so famous an explorer as Drygalski. This book is written primarily for the student of physical geography, but it will interest all scientific men and laymen who have studied glaciers and have attempted to solve some of the fascinating and paradoxical problems which their behaviour so often presents. The comprehensive contents touch all aspects of glaciology, from the physics of glacier flow to the climatological implications of recent changes of glaciation.

A historical introduction is followed by three chapters devoted to more elementary topics: the definition of the snow line, the classification of glacier types, and glacier economy. A descriptive section on avalanches is appended to the first chapter, but contains little reference to the fundamental work on that subject which was recently done in Switzerland. The chapter on glacier economy gives a clear and balanced account of the different factors affecting accumulation and ablation, and of the difficulties which their exact estimation involves; descriptions of "Büsserschnee" and other unusual effects of ablation are also included, though the explanations of their origin could have been made clearer with the help of illustrations. The scarcity of these is felt throughout the book, and particularly in the chapters on the physics of ice and the structure of glaciers. The general standard of these two chapters falls a little behind that of the rest, partly because the authors treat the plasticity of ice as an isolated phenomenon, while it is surely but one aspect of the mechanical behaviour of polycrystalline materials in general.

The sections on ice stratification and banding in glaciers are somewhat obscure, and fail to dispel the mist of confusion in which that subject is still, perhaps rather unnecessarily, shrouded. Apart from these minor defects, the chapter on glacier structure and the succeeding one on glacier flow are well balanced, since the authors steer clear of all the exclusive theories of glacier flow which have caused

such heated controversies in the past; they succeed in representing glacier flow as a complex and composite phenomenon which is still far from being completely understood. The chapter on moraines which follows is one of the best.

The book derives its main strength from the authors' own remarkably wide experience of glaciers in all parts of the world. One would naturally expect two Munich professors to concentrate on data collected from the Alps. Instead, the glaciers of Greenland and Spitsbergen, the Antarctic and the mountain chains of Central Asia are all treated with familiarity and competence. This world outlook not only adds interest to a long chapter on the geographical distribution of glaciers, but also impresses on the reader the immense variety of glacier forms and behaviour, and cautions him lest he should draw too wide generalizations from his own limited experience in one particular part of the world. The last chapter deals with glacier variations, and contains a wealth of information concerning the changes of landscape and climate which have accompanied the advance and recession of glaciers in historical times. The authors are at pains to demonstrate the limitations of various theories of climatic cycles and to show that glaciological data provide no support for their existence. The rapid recession of glaciers in all parts of the world since about 1850 must fill the reader with alarm, lest glaciology become a science of the past before the manifold forms and processes exhibited by these great ice-streams have been properly understood.

The references in the book to the literature of glaciology are extraordinarily complete, though their arrangement might have been improved; there is no index of authors and the subject index is far from adequate; the shortage of illustrations has already been mentioned. Some of these failings may have been due to war conditions, yet it is a pity that they should detract from the usefulness of an otherwise admirable text-book.

M. F. PERUTZ

THE DOCTORS' DIAGNOSIS

A Charter for Health

By a Committee of the British Medical Association under the Chairmanship of Sir John Boyd Orr. Pp. 96 + 18 plates. (London: George Allen and Unwin, Ltd., 1946.) 6s. net.

THIS attractively produced little volume, with its well-chosen photographs and simple coloured graphs of vital statistics, is clearly directed towards the intelligent general public (although one suspects that the rather high price may reduce its circulation considerably) and gives a simple, clear and authoritative statement of the factors affecting the health of the individual and the community. In the words of the final chapter, "The doctors collectively have in the preceding chapters attempted to diagnose the nation's condition", and their attempt has been very successful. The further claim to "have given a prescription to guide the community" could, however, scarcely be substantiated, and this for the very good reason that medical practitioners as such have no greater skill in political prescription than politicians have in medical. In a way, the committee of authors recognizes this, for the preface informs us that "Controversial issues have been avoided"—and what more controversial than politics? Within this self-imposed limitation, however, the Committee has done an excellent piece of work.

Beginning with a forward-looking statement on the role of medicine through which the conception of 'positive health' runs and in which some recent advances in medicine are surveyed, the book proceeds to consider preventable disease and adduces statistics of unnecessary morbidity which cry aloud the need for immediate action. Then come chapters on the family and the home which follow the views of most competent authorities, and contain recommendations which, if implemented, would materially benefit the physical and mental health of our citizens. A chapter on food points out the need for government action in improving the nutrition of our people, and indicates the path as clearly as any book intent on avoiding controversial issues could do; while chapters on occupation and recreation balance the needs of work and leisure. Mental health is the next subject, which is covered as adequately as so many topics as emotional security, habit formation, preparation of children for the arrival of a new baby, delinquency, sex education, adolescence and marriage can be in some seven pages in all. The next chapter, on health education, puts forward some concrete suggestions on the content and method appropriate to particular ages, and is followed by some statistics of mortality and morbidity which provide excellent ammunition for fighters for a 'new deal' in health.

The book thus covers an extraordinarily wide field in small compass, and it would be quite unfair to criticize it on the grounds of superficiality. There are, however, some respects in which criticism is valid.

The language is sometimes verbose ("The improvement of health and the prevention of disease should progress together. All the weapons which serve this purpose should be used simultaneously and advantage should be taken of all the means which medical science increasingly affords and medical research may hereafter disclose"), occasionally platitudinous ("The child's place in school should be suited to his capacity, neither above it nor below it"), in places somewhat technical ("a survival from the arboreal habits of anthropoid ancestors in forests infested with prowling carnivora of nocturnal habits") and in at least one sentence open to double interpretation ("Many still-births and premature births are due in large measure to the malnutrition of the mother or her employment in arduous labour towards the end of pregnancy" !). The Committee, moreover, in its statement that "Only very recently has any headway been made, mainly due to the work of the Central Council for Health Education, in breaking down public prejudice" against venereal diseases, is less than fair to the valuable pioneer work of the British Social Hygiene Council in this field.

One other point of criticism is that the Committee (consisting almost entirely of men) does not seem to appreciate fully how valuable a part a well-trained husband can play in home and family life. Why, for example, should the education of girls be "designed to teach them the art of home-making" and not that of boys? Why should the mother represent the "background of the home" and the father "all the outward striving away from the home"? And, while on this topic of the respective roles of the two parents, is it not rather surprising to read that "The mother's occupation is . . . above all, to bring children into the world"? Shades of 'kids, kirk and kitchen'!

But when all criticism is made, this book remains a most useful piece of work, and the British Medical Association Committee is to be congratulated on it.

CYRIL BIBBY

A LARGE ASTRONOMICAL TELESCOPE FOR GREAT BRITAIN

A DISCUSSION on the use of a large telescope in Britain took place at a meeting of the Royal Astronomical Society on June 14. This discussion had its origin in the presidential address delivered to the Society earlier in the year by Prof. H. H. Plaskett, who pointed out that, lacking a telescope of large light-gathering power, British contributions to a large part of observational astronomy would of necessity become practically negligible. He also emphasized the interrelation between observational and theoretical work, and reminded the Society how in the past the advance of physics has depended upon observational discoveries in astronomy. He put forward suggestions for the construction of an instrument of the Schmidt type with a mirror of 74 in. aperture, suitable both for direct photography and for slit spectroscopy. The estimated cost of such an instrument, with proper ancillary equipment, is £100,000, and Prof. Plaskett suggested that the Society should take the initiative in making application for the necessary capital cost and running expenses, the idea being that the equipment should be installed at a suitable central site and should be available for use by all the observatories in the United Kingdom.

During the four months following Prof. Plaskett's address, British astronomers gave his proposal active consideration, and a crowded meeting at Burlington House on June 14 heard the scheme fully and freely discussed. In the absence abroad of the Astronomer Royal, Sir Harold Spencer Jones, his opening contribution on observing conditions in Great Britain was read by Dr. R. d'E. Atkinson. Sir Harold pointed out that estimates of night cloudiness at a particular site must, in the absence of direct data, be made by rather roundabout methods. At Greenwich, night sky records have been made by obtaining trails of circumpolar stars with a fixed camera, and there is a general positive correlation between the yearly totals of clear sky obtained from these records and the annual sunshine totals. Sunshine records indicate that the south-east is the most suitable region in England for astronomical observations. On the basis of the sunshine records for Herstmonceux Castle (the new site chosen for the Royal Greenwich Observatory), Sir Harold predicted that for this site 1,500 hours of clear dark sky should be obtained in an average year.

The question before us, then, is whether this total of 1,500 hours is enough to justify the installation of a large telescope. Sir Harold pointed out that only a small fraction of the astronomer's time is spent in actual telescope work. For most observations by far the larger part of the total work is taken up by plate measurement, reduction of the measures and analysis of the raw material thus obtained. For a long-term, fairly routine programme, such as stellar parallax work, the ratio of observing to non-observing time is found by experience to be about 1 to 8. In such work only a few stars are measured on each plate; but for positional work, such as zone photography with a wide-angle lens, hundreds of stars are measured on a single plate, and heavy computations are involved; for this work the ratio may reach 1 to 700. Between these two extremes lie ratios applicable to other programmes, and as a rough average the office time required can be put down as a hundred times the observing time. With this ratio, an annual total of 1,500 hours observing time would keep a considerable number of astronomers fully occupied, a conclusion which is confirmed by experience with the 72-in. reflector at Victoria, B.C., where the annual total of clear night sky is less than 1,500 hours. From the magnificent results obtained there on a variety of well-planned programmes, Sir Harold deduced that the installation of a large telescope in southern England would be fully justified. This conclusion was of great interest to the meeting, since some rather defeatist statements have been made in the past to the effect that the British climate is such that no adequate return can be expected from the erection of a large telescope.

The discussion was continued by Prof. W. M. H. Greaves, Astronomer Royal for Scotland, who said that it was his task to outline the programmes for which the proposed new equipment could be used. He proposed to fulfil this task by asking a rather wider question: What contributions can British astronomers make to the major problems of astronomy, given the requisite equipment? Refusing to subscribe to the view that we should be solely concerned with the provision of a large telescope in Great Britain, he said that the major problems demand observational material from both hemispheres, and in the present state of the world it is largely for the countries of the northern hemisphere to make adequate provision for work in southern latitudes. British astronomers cannot escape their responsibilities in this direction, especially as the British Commonwealth includes southern countries with good climatic conditions. How, then, are our responsibilities being met as regards the major problems of astronomy, and what can be done given the proposed new equipment?

One major research is the study of the structure and dynamics of the galaxy, and this requires photometric work combined with good proper motions, parallaxes and radial velocities. As regards proper motions and parallaxes, we are already playing our part, and we can be confident that the Greenwich and Cape Observatories would see to it that we continue to do so. As regards radial velocity work, the proposed programme with the 74-inch telescope at the Radcliffe Observatory, Pretoria, will complete the magnificent work done in the northern hemisphere at Victoria, and the two series will constitute an achievement of which British astronomers can be proud. But galactic research is primarily based on photometric work; the main observational raw material consists of counts of stars down to assigned apparent magnitudes in various fields of the sky, and the evaluation of the absorption of light by interstellar material is a photometric problem. The necessary photometric programmes consist of (*a*) a large-scale survey of areas distributed over the whole sky, which would lead to a general smoothed picture of the galactic system; and (*b*) a more detailed survey based on the study of areas selected for the enhanced presence or absence of obscuring material. It is essential that the photometry should be of first-class quality; there is no room in this research for poor quality mass-production.

The British contribution to this very important photometric work is, to our shame, practically zero at present. As regards (*a*), the Mount Wilson survey can be said to have met the immediate requirements in the northern hemisphere, but there remains (*b*) where we could play an important part if we had

large telescope of the Schmidt type. When we come to consider the state of the southern hemisphere work, the sad fact emerges that, so far as photometry of precision is concerned, astronomy has practically the whole way to go in both (*a*) and (*b*). Here is a chance for redeeming our past neglect in one of the major problems of astronomy. Prof. Greaves believes that in determining our contribution we should give priority to the erection of a Schmidt telescope in the southern hemisphere, to be operated by British astronomers. But northern work is very important; we should play our part by erecting a large Schmidt telescope in Great Britain as well.

Another major problem is the study of the physics of individual stars and other celestial objects. In this comparatively young and rapidly developing subject, the main observational weapon is the spectroscope. But to obtain spectra of reasonable dispersion, one must feed the spectroscope with sufficient light, and at present we are not playing our part mainly because our instruments are too small. By the imminent erection of the 74-in. reflector with spectroscope at Pretoria we could claim that we are playing our part in southern work, but observations in both hemispheres are necessary. To maintain the necessary close association of astrophysics with the main body of physical science under present conditions, we must push on with observational astrophysics, including the development of new methods, in Great Britain. But the tendency for clear sky to occur in comparatively short spells in the British Isles is emphatically against any programme involving long exposures, and to obtain material of real value a large telescope is a necessity. Prof. Greaves commented that if anyone wished to carry out any particular astrophysical programme in both hemispheres, and if he only had funds for, say, a 72-in. and a 36-in. reflector, then common sense would dictate that the larger instrument should be erected in Britain, and the smaller in a country like South Africa where the climate is suitable for long-exposure work. The two parts of the programme would then keep in step. As it is, unless the proposed equipment is forthcoming, he believes that we in Great Britain will lag behind in observational astrophysics. There is plenty of work to be done, but a large telescope is a necessity if we are to take part in it.

With regard to the cosmological study of the universe of galaxies, which constitutes a third major research, Prof. Greaves said that at present we are contributing precisely nothing. Good photometry can discriminate between some of the rival hypotheses that have been advanced, but so far the very valuable pioneer work that has been done does not come up to the requisite standard of photometric precision; given a large Schmidt instrument we could play a notable part. He concluded by saying that in all three of the major problems considered, we could contribute materially given the necessary equipment, but that without such equipment our contributions would remain practically ineffective and British observational astronomy would slowly die. The connexion between observational and theoretical astronomy is so intimate that the latter could not long survive the death of the former; and the death of British astronomy could only inflict harm on the main body of physical science.

The meeting then considered details of the proposed instrument. Mr. F. J. Hargreaves dealt with the mechanical problems involved in the design of a large telescope. Not all mountings, as he pointed out, allow all parts of the sky to be reached, and the fact that the mirror alone of a 72-in. reflector would weigh about two tons means that the engineer is set many problems in avoiding flexure. With the aid of diagrams, Mr. Hargreaves described the two main classes of mounting: the 'overhung' type, in which a declination axis, set at right angles to the polar axis (about which the instrument turns), carries the main tube at one end balanced by a counterweight at the other; and the 'trunnion' type, in which the tube is slung within the polar axis and is thus supported from both sides, a counterpoise being unnecessary. Each has its advantages and drawbacks, and Mr. Hargreaves described some possible ways of combining the good points of each without their disadvantages.

A desirable feature of a modern telescope, incorporated in the new 74-in. Radcliffe reflector, is an optical laboratory, below the dome floor, into which the light is directed by auxiliary reflectors. This avoids the need for carrying heavy or awkwardly shaped apparatus on the telescope itself, and enables the observer to work in comfort in controllable conditions. With the overhung construction modified as at Pretoria, this can be achieved with only two additional reflexions, but with the conventional trunnion mounting four are needed. Mr. Hargreaves suggested a modification of his own which eliminates two of these, and concluded by showing how this could be combined with many of the good mechanical features of other existing mountings to give a design for the proposed new telescope which could be both mechanically sound and optically efficient.

In a contribution concerned entirely with arriving at the most desirable optical train for the telescope, Dr. E. H. Linfoot pointed out that the classical Cassegrain can scarcely be bettered as a condensing system for stellar spectroscopy, but it has a very limited field. A better system for astrographic work is the Schmidt camera, in which the aberrations of a spherical mirror are removed by a figured plate at its centre of curvature. Speaking as an optician with an interest in astronomy, Dr. Linfoot recommended a Schmidt telescope of aperture ratio about $f/3{\cdot}5$ and focal length 14 or 15 ft. (stop diameter 50 in. for an unvignetted field of 7°), convertible into a 72-in. spectrograph condenser by the addition of a small auxiliary convex mirror.

Dr. C. R. Burch, in agreeing with Dr. Linfoot's conclusions, appealed for a design which would not be determined by any cheese-paring austerity considerations. Quite apart from the astronomical value of a large telescope in Great Britain, its design and construction would, in his view, stimulate and inspire the technical opticians and the optical industry to an extent which would in large measure justify the cost. Astronomical optics has already provided new ideas for use in microscopy, for example, and there is no reason to believe that the fountain of good ideas has run dry.

To add point to this last remark, Mr. W. J. Bates then described a new device for testing mirrors which he has called a 'wave-front shearing interferometer'. Two views of the wave-front coming from the mirror are formed by division at a half-silvered surface, and are recombined with a relative displacement or shear. Interference fringes are thereby formed which are analogous to the contact fringes obtained by moving a test-plate of the same asphericity over the mirror under test. The method eliminates

the usual comparison beam necessitating a worked surface comparable in dimensions with that to be tested, and the apparatus (which was exhibited) in its present undeveloped state occupies about a six-inch cube. It might therefore be attached permanently to the telescope for frequent tests under working conditions.

Dr. W. M. Hampton, technical director of Messrs. Chance Bros. and Co., Ltd., next spoke on the construction of the mirror. As a material capable of taking a high polish, with a hard permanent surface and low thermal expansion, he said, glass is unrivalled. No technical difficulties would arise in the production of a 72-in. blank in Great Britain, though there would be serious commercial ones. A supply of suitable glass already exists; the difficulty would be in the provision of facilities and especially space for transferring it from the furnace to the moulds and annealing kilns. Dr. Hampton emphasized, however, that his remarks applied to the glass for the main mirror, where its function is to provide an accurately figured surface. A Schmidt plate presents a very different problem, since the highest optical homogeneity is required for this, and a low-expansion glass has never yet been produced in the requisite optical quality.

The meeting then proceeded to more open informal discussion. A question from Prof. Greaves elicited the fact that, should an instrument of longer focal length than the 15 ft. of Dr. Linfoot's design be required to separate close images in densely populated Milky Way clouds, it could easily be obtained at the cost of a somewhat reduced angular field. In Prof. Plaskett's view, however, the overriding requirement is the resolution of the tremor disks of adjacent stars on the photographic plate, and the optimum focal length is set by this consideration. Mr. F. Hoyle welcomed the proposed telescope on the ground that if a large instrument could enable astronomy to contribute one really new idea to physics, the result might amply repay the initial cost. Mr. G. M. Sisson, of Messrs. Sir Howard Grubb, Parsons and Co., welcomed Mr. Hargreaves's design as a practical solution of the major difficulties, but deprecated the use of roller bearings, which deform seriously under load. He put in a plea for the modified English yoke mounting, especially if spectroscopic equipment is to add to the length of the tube, and hoped that the virtues of the Wright camera and of the Gaviola test would not be overlooked.

A lively discussion ensued on the practicability of various new materials for different components of the telescope. On a plea for high conductivity as well as low expansion for the mirror, even speculum metal was proposed, in view of the fact that vacuum evaporation has now removed the bogy of tarnishing. Technical difficulties of casting speculum metal, however, led another speaker to urge the superiority of a low-expansion cast iron such as 'Minvar'. Low thermal expansion, as Dr. Linfoot pointed out, is not necessary for the Schmidt plate, and the merits of 'Vitaglass' for the purpose were discussed. Transparent plastics, it was agreed, are quite unsuitable for this plate.

The discussion as a whole revealed extensive support for the views put so forcibly by the Astronomer Royal for Scotland in its early stages; the desirability, even the necessity, of a large reflecting telescope in Great Britain was generally conceded. About the details of the design, divergences of opinion became apparent. But in a scheme of this sort, such differences are inevitable and are to be welcomed; there will be time to thrash out the details when the principle is approved. It is clear that the main body of informed opinion among astronomers in Great Britain is in favour of the provision of a large telescope here, and there will be general support for the Royal Astronomical Society in its application for funds to construct and erect it. The prestige of the Royal Society has been lent to the scheme, and Sir Robert Robinson, president of the Royal Society, was able to announce at the opening of the Newton Tercentenary celebrations on July 15 that the Chancellor of the Exchequer would ask Parliament to devote a sum of money for the purpose. Details are not yet settled, but it is now agreed that the Isaac Newton Observatory, as it is to be called, should comprise not a mere 72-in. but a 100-in. reflector together with ancillary equipment.

POLYMERS AND POLYMERIZATION

ON April 4, the Chemical Society held an afternoon symposium to discuss certain matters relating to high-polymer chemistry in which significant advances have been made recently. Six speakers contributed to the discussion, but, since the Chemical Society will publish the papers in full, only a few of the salient points of more general interest need be mentioned here. The first part of the discussion dealt with problems connected with the mechanism of the synthesis of high polymers, and the second part more particularly with the structure of such polymers.

The development of synthetical techniques has revealed at least three distinct ways in which macromolecules may be formed; and the simplest from the purely chemical point of view is the process of polycondensation, exemplified by the combination of dihydric alcohols with dibasic acids to form superesters. These reactions take place by a step-like process. That is, each step is kinetically similar though not identical. The unfortunate fact is that polycondensations cannot be studied in dilute solution, and therefore it is impossible to determine whether molecular size has any effect at all on the magnitude of the kinetic coefficients; nor is it possible to say why in any given case there seems to be a practical upper limit to molecular weight. The next important class is the polymerization of ethylene derivatives in the gas and liquid phases at room temperature and above. Here considerable progress has been made in getting a fairly detailed picture of the mechanism. The third class are those polymerizations which occur at low temperatures, for example, $-80°$ C. and are catalysed by substances of the Friedel-Crafts type, namely, BF_3, $AlBr_3$, etc. These are confined to hydrocarbons, though there is no doubt that other types of molecule may be made to polymerize in the same way. There may be other types of process, for certain peculiarities so far observed may not come under any of the above headings; but these matters are still too uncertain to be profitably discussed here.

The Friedel-Crafts type of catalysis was discussed by Prof. M. Polanyi. The facts may be summarized briefly by saying that reaction occurs exceedingly rapidly, that products of higher molecular weight are obtained, that the reaction has a high negative temperature-coefficient. It would appear that besides

the catalyst a minute trace of water is necessary to start the reaction. Polymerization at higher temperatures certainly goes by means of free-radical mechanisms but, because energy of activation is necessary for the growth reaction, there is no likelihood of a similar mechanism operating at −80° C. The low-temperature process must therefore occur by another mechanism not yet finally decided. Opinion strongly favours an ionic mechanism in which a proton first adds to an isobutene molecule

$$CMe_2{=}CH_2 + H^+ = \overset{+}{C}Me_2{-}CH_3,$$

a carbonium ion being thereby produced.

It is difficult to get any direct evidence of the existence of such an ion, because the concentration required to ensure fast polymerization is so extremely small. The so-called propagation or growth-step involves then the transfer of the positive charge to the monomeric unit just added:

$$CMe_2{=}CH_2 + \overset{+}{C}Me_2{-}CH_3 \rightarrow \overset{+}{C}Me_2{-}CH_2{-}CMe_2{-}CH_3.$$

This reaction must possess practically zero energy of activation since it occurs so readily. The growth can only be stopped by the neutralization of the positive charge or by the abstraction of a proton by a negative charge. The latter is the more likely process, and consequently the termination reaction is

$$CMe_2{-}CH_2{-}CMe_2{-}CH_3 + \varepsilon \rightarrow H^+ + CMe_2{=}CH.(CMe_2CH_2)_nCMe_2.CH_3.$$

The experimental difficulties in carrying out these reactions are so great that well-defined techniques cannot easily be applied to yield further information about the kinetics.

Prof. M. G. Evans discussed some further advances in studying the polymerization of a number of vinyl derivatives in aqueous solution; such as styrene, methyl methacrylate, vinylidene chloride. With the exception of methacrylic acid, the polymer is precipitated from solution; thus a new solid phase appears during the course of polymerization. It has been known for some time that hydrogen peroxide and also persalts catalyse polymerization, but the process can be considerably accelerated by the addition of a reducing agent, such as Fe^{++}. With the hydrogen peroxide–Fe^{++} system oxygen is evolved, but in presence of sufficient monomer it is supposed that the reaction

$$Fe^{++} + H_2O_2 = Fe^{+++} + OH^- + OH$$

occurs, and that the free hydroxyl radicals are taken up by the monomer. Normally, of course, two radicals would give rise to one molecule of oxygen although there is a competing reaction

$$OH + Fe^{++} = OH^- + Fe^{+++}$$

with excess Fe^{++}. In the latter case, $2Fe^{++} \equiv H_2O_2$, whereas in presence of monomer, $Fe^{++} \equiv H_2O_2$. Thus measurement of the rate of disappearance of the hydrogen peroxide gives at once the rate of production of hydroxyl radicals and therefore the rate of initiation of polymer chains. Although the absolute rate of interaction of hydroxyl with various monomers cannot be obtained, the relative values may be obtained using the $OH + Fe^{++}$ reaction as the basis of comparison. If hydroxyl radicals start polymerization by addition to a vinyl compound, thus forming $HO{-}(CH_2{-}CHX)_n.CH_2{-}CHX{-}$, there is the possibility they may add on to the chain and so ultimately stop growth. In such a case each polymer molecule would contain two hydroxyl groups. On the other hand, it may be that growth stops when two large free radical polymers interact. If these combine, a polymer molecule of the structure $HO{-}(CH_2{-}CHX)_nOH$ will also be produced. The number of polymer molecules in a given sample can be counted by means of an osmometer, and the number of hydroxyl groups by the methane evolved on treatment of the polymer with methyl magnesium chloride. The result is that there are two hydroxyl groups per polymer molecule. Kinetic analysis, however, shows conclusively that cessation of growth occurs by the combination of two radicals. This precise knowledge of the mechanism then enables the distribution of molecular weights to be computed on the assumption that the velocity coefficients for growth and termination do not depend on molecular weight. Fractionation of the polymer gives a result in good agreement with theoretical prediction. Emulsifying agents have a profound effect on the rate of reaction but do not affect the rate of production of hydroxyl radicals. Hence the growth or termination reactions must be affected, but no decision can as yet be made as to which process is affected. It is simplest to assume that the rate of termination is cut down.

Prof. H. W. Melville discussed a further extension of polymer kinetics, namely, the determination of the individual values of the velocity coefficients for the growth (k_p) and the cessation of growth (k_t). Measurements of the rate of polymerization can only give the ratio of k_p to k_t. In order to compute the individual values, another factor must be measured. This is the stationary concentration of the growing polymers. Owing to their high reactivity, the concentration (P) is invariably so small (for example, 10^{-9} moles/litre), that no physical method is sufficiently sensitive even to detect their existence. However, it can be shown that to a first approximation $d(P)/dt = (P)/\tau$, where $d(P)/dt$ is the rate of initiation of polymerization and τ is the time for growth of the chain.

$d(P)/dt$ can be obtained in both catalytically and photochemically initiated reactions, but τ can only be determined in photochemical reactions by making use of the fact that the rate is usually proportional to the square root of the intensity of the incident light, in which case with intermittent illumination the rate of polymerization depends on the frequency of the intermittency. By suitable analysis τ can be found. k_p and k_t can then be calculated as a function of molecular size and of temperature. With vinyl acetate in the liquid phase, it turns out that the energy of activation for the growth reaction is quite small—4,400 Cal. The velocity coefficient does not diminish much with increasing molecular length. In pure monomer such a result is not surprising, because monomeric molecules must always be in the neighbourhood of the active end of the polymer at which growth occurs. The velocity coefficient for termination is not dependent on temperature, a fact which would not be surprising if termination of chains were due to the interaction of free radicals.

That the active polymer does in fact consist of free radicals is probable from these facts. It is practically certain that benzoyl peroxide gives rise on thermal decomposition to radicals that initiate free radical polymerization. Similarly, photochemical decomposition of the peroxide gives rise to a reaction with similar characteristics. Again, the direct photo reaction is similar to the photosensitized reaction. Exact molecular weight measurements of the resultant

polymer show conclusively that the large radicals disproportionate instead of combining.

The determination of the structure of high polymers is of the utmost importance, for the mere formulation of the chemical equation cannot indicate anything about the stereochemistry of the polymer, nor does it reveal side-reactions that may occur, giving rise to structures not expected from the 'straight' chemistry of the reaction. X-ray methods and infra-red methods supply some of the lacking information. Molecular weight determinations of high polymers must be made in solution, and hence it is of fundamental importance to have complete information regarding thermodynamic properties of their solutions.

What should be the most direct approach is the application of X-ray diffraction methods; but Mr. C. W. Bunn showed just how far such methods may be applied and also what severe limitations, and possibly insuperable limitations, still exist even with such a powerful method of attack. Before X-ray methods can be used, there must be produced within the solid polymer a considerable degree of internal order by the arrangement of the extended molecules in bundles. Unfortunately, this cannot be done with many polymers which have been thoroughly investigated by other methods. The most notable exceptions are polyacrylates and polymethacrylates, and polyvinyl acetate. The X-ray diffraction patterns produced by these amorphous polymers yield practically no information regarding their constitution. On the other hand, quite a number of vinyl polymers, poly-esters, polyamides, and polydienes give well-defined patterns indicative of a high degree of internal order, provided they are stretched as in rubber or are drawn into fibres as in polyamides.

The simplest example is polyethylene. Here there is a repeat distance along the chain of 2·5 A. This simply means that all the carbon atoms are coplanar in a large part of a single molecule. Similarly, if one of the hydrogen atoms of the ethylene unit is replaced by hydroxyl giving polyvinyl alcohol, the repeat distance remains unaltered. This means that all the OH groups are on one side of the backbone. Such an arrangement is highly uniform, and thus strong hydrogen bonding ensures easy crystallization of the polymer. The acetylation of the alcohol introduces a bulky group which prevents crystallization. If two bulky substituents replace the hydrogens on one carbon atom, the repeat distance is less than that of a fully stretched chain. The carbon chain must then be coiled to the same extent if normal internuclear distances are to be maintained. The same behaviour is exhibited by polyisobutylene because of the bulky methyl groups. There are, unfortunately, many ways in which chain-shortening can be carried out, and consequently the interpretation of the diffraction pattern becomes extremely difficult. In most cases a complete structure analysis must be made. Fortunately, with polymers such as polychlorobutadiene and guttapercha the analysis is possible; but with natural rubber the system has not yet been fully worked out. These complications increase with the size of the monomeric unit, but it is of interest to note that

$$-CO(CH_2)_4CO.NH(CH_2)_6.NH-$$

exists as a fully stretched molecule in the crystalline fibre.

The infra-red absorption spectrum of polymers provides a complementary method of structure analysis, as was pointed out by Dr. H. W. Thompson. In long molecules with repeating units, it is impossible to treat the whole molecule as a vibrating system as is done with small polyatomic molecules. Instead, the various types of links give rise to well-defined absorption bands. The precise position of such bands depends on the structure of the monomer units and also of their environment. One of the most important facts that has been established in certain polymers, for example, polyethylene, is the appearance of groups the presence of which would not have been inferred from the chemistry of the reaction. Small amounts of oxygen are used as a catalyst in this polymerization reaction, so that the proved presence of CO groups is not surprising, but the existence of CH_2 groups does raise serious questions regarding the mechanism of polymerization. In ethylene derivatives the disappearance of the double bond is so vital a change in the structure that small amounts of monomer may be detected in the polymer, and the progress of polymerization may easily be followed by watching the disappearance of the double bond. In the polymerization of dienes, infra-red methods enable a discrimination to be made between 1,2 and 1,4 structures, namely, $-CH_2-CH(CH=CH_2)-$ and $-CH_2-CH=CH-CH_2$ for butadiene. While it is true this could have been done by ozonolysis, the infra-red technique is speedier and more convenient.

Another recent discovery is that in substituted phenol formaldehyde resins the OH-frequency of the phenolic hydroxyl group is subject to wide variations, which would imply that orientation of the benzene rings in such resins may play a much more important part than has been realized in determining other properties. An unfortunate limitation is that in long polymers the nature of the end groups cannot be determined. This is one of the most pressing problems, because both chain initiation and termination are concerned at the ends of the molecule; yet little is known of the structures at the ends.

Dr. Geoffrey Gee discussed the thermodynamic approach to the investigation of the nature of solutions of high polymers. Unfortunately, the most difficult part of the subject concerns dilute solutions which are of interest for molecular weight determinations; but since concentrated solutions can be dealt with more satisfactorily, the analysis produces information about the function of plasticizers and about the interaction of polymers with solvents when swelling occurs. Briefly, the general argument is as follows. In considering the equilibrium between the solution of a polymer and the vapour in equilibrium with the solution, the fundamental quantity that governs the system is the Gibbs' free energy of dilution $-\Delta G$. From a knowledge of this quantity many important predictions may be made. Measurement of the effect of other factors such as temperature, surface tension and pressure permit additional factors to be computed, in particular the heat $-\Delta H_e$ and entropy ΔS_e of dilution. The values of ΔG_e and ΔH_e so obtained thus provide data for inquiring more closely into the nature of the solutions, for this is much more complex than dealing with two miscible liquids. Assuming random mixing of polymer and solvent, it is presumed that ΔH_e should vary as the square of the volume fraction of the polymer.

The important fact is that the constant of the equation expressing ΔH and volume fraction cannot be calculated from first principles, although an approximate estimate may be made from the cohesive

energy density of the liquid and an estimated value for that of the polymer, since this, of course, cannot be determined. According to statistical mechanics, the entropy of dilution is related to the logarithm of the number of ways in which a polymer chain can be arranged in the liquid. Here various restrictions must be imposed. The chain must be divided into units (not necessarily monomeric units) that are equal in volume to the solvent molecules. The chains must be completely flexible. The problem in statistics, then, is to calculate the maximum possible number of configurations. Unanimity of opinion has by no means been reached in this matter, but the general form of the equation is fairly well established.

Again, however, further work is necessary before a satisfactory solution can be achieved. It may be that statistical mechanics has reached a limit beyond which it cannot go because sufficiently complete information is not available about the nature of the polymer chain. Further progress will therefore be held up until new methods are devised to supply this lacking information.

COLLEGE OF AERONAUTICS

By E. F. RELF, C.B.E., F.R.S.
Principal

THE College of Aeronautics, which is to be opened at Cranfield, Bedfordshire on October 15, 1946, will treat advanced aeronautical education in a way which differs very considerably from that which has been followed in the past in British universities which have a department of aeronautics. In such universities post-graduate study in aeronautical subjects has been mainly of an academic character, and those students who have afterwards gone into industry have had to obtain their practical experience later, greatly helped by the sound general scientific or engineering background they had first acquired. The new College is intended to provide both the sound theoretical background and the practical training, and to show the relation between theory and practice as clearly as possible. It is hoped, in this way, to build up a centre of aeronautical learning of the highest standard, and to help to maintain British pre-eminence in the aeronautical world by training men who will ultimately become leaders of thought, whether in the industry, the research establishments, or in other places.

The history of this new endeavour begins in 1943, when Sir Stafford Cripps asked the Aeronautical Research Council to discuss the matter. On receiving a confidential report from the Committee, the Minister set up an interdepartmental committee presided over by Sir Roy Fedden to elaborate the scheme. The report of Sir Roy Fedden's Committee was published by H.M. Stationery Office under the title "A College of Aeronautics" (see *Nature*, **154**, 621; 1944), and envisaged the building of a college near an existing airfield so that flying facilities might be readily available. A very full description of the aims and objects of the College was contained in this report, together with the reasons which led the Committee to advocate a new establishment rather than the extension of existing facilities in the universities and elsewhere. Appendixes to the report gave full details of the staff and equipment which would be necessary, and of the subjects to be covered.

It was evident that this extensive scheme could not be carried into full effect for a number of years, on account mainly of the difficulty of building in the immediate post-war years. The report itself suggested that an early start might be made by adapting existing buildings, and, after some exploration of possible sites, this plan was adopted and advantage taken of the offer of the Air Ministry to make a part of the R.A.F. Station at Cranfield available for the purpose. This Station has excellent brick buildings which have not been camouflaged, pleasant surroundings, and a very good airfield with unobstructed approaches.

The initial financing of the College was undertaken by the Government through the Ministry of Education, as recommended in the Fedden Report, which also recommended that control should be placed in the hands of a board of governors and that the control exercised by the Ministry itself should "not be too meticulous". The general atmosphere in the College was to be rather like that in a university, with considerable academic freedom for the staff. In June 1945 the Board of Governors was set up under the chairmanship of Air Chief Marshal Sir Edgar Ludlow-Hewitt, recently inspector-general of the R.A.F., and its members, appointed by the Minister of Education, represent a very wide range of interests connected with the College. The Board of Governors has laid down the broad policy to be followed and has appointed most of the senior staff of the College, who are now occupied with the task of preparation for the opening in October. The decision has been taken that Cranfield shall be the permanent home of the College, there being ample facilities for expansion as the need arises. The site is a convenient one, being almost equidistant from London, Oxford and Cambridge, and being quite near the new Research Establishment which is to be established at Thurleigh, north of Bedford.

At its inception, the College will consist of three main departments, dealing respectively with aerodynamics, aircraft design and aircraft propulsion, together with a flight section. As experience is gained, decisions will be taken as to the desirability of establishing other departments, such as those proposed in the Fedden Report dealing with aircraft instruments and with production. There will be sections under the three main departments covering ancillary subjects like mathematics, materials and metallurgy, electronics, and dynamics, so that students who need it can obtain sufficient instruction in these subjects to make their study of the primary subjects fully effective. The Flight Section will cater for the needs of all the departments and enable the students to follow their lecture-room and laboratory studies into the air and see how flight experimentation is employed to check and confirm theoretical and practical work in the design office.

The College will open with a two-year course at post-graduate level, though the actual possession of a degree is not essential for entry. In the first year, students will be given a broad general training in all the departments, while in the second year they will specialize in the subjects which they wish to make the basis of their subsequent career. It is intended later to establish short courses and refresher courses to meet any needs that become apparent. In all the courses particular care will be taken to ensure that fundamental principles are thoroughly grasped and understood, in order that students may be well prepared to deal with any problems they may

eventually meet. At the same time, the practical instruction in the laboratories will be made as extensive as possible, since so much of aeronautical knowledge at present rests upon the foundation of experiment.

The laboratories of the College will not be by any means complete at the date of opening, but will contain enough equipment to cover the first courses. They will be built up as time goes on and will ultimately become extensive. There will be two large laboratories containing wind tunnels of various kinds for the Department of Aerodynamics, including, in due course, small high-speed and supersonic tunnels. Two similar laboratories will be devoted to aircraft design and will contain testing machines and test frames in which the strength and elastic properties of complete wings and fuselages can be studied. The Engine Laboratory will contain examples of all kinds of engines, including some of the latest gas-turbine types, and there will be test houses in a more remote part of the College grounds where reciprocating and turbine units can be studied under running conditions. In addition, there will be many smaller laboratories to house smaller equipment and to cover the needs of the ancillary subjects. It is hoped that all these provisions will be completed in time for the commencement of the second-year course, in which the larger and more elaborate items of equipment will be more urgently needed than in the first year.

Every endeavour will be made to keep the teaching thoroughly up to date, a matter of the greatest importance in view of the fact that aeronautical science is progressing even more rapidly to-day than it has done in the past. For this purpose the closest touch will be maintained between the senior staff of the College on one hand and the industry and research establishments on the other. The fact that the Principal and some of the staff are closely associated with the activities of the Aeronautical Research Council will help greatly to ensure that the latest developments are known to those responsible for the teaching.

Students are now being selected for the opening course at the College. Selection is made by a board of entry and is based on a written application supplemented, when considered necessary, by an interview. Anyone who is interested can obtain all particulars by writing to the Registrar of the College.

The social amenities have not been forgotten; Cranfield is in a somewhat isolated position, being ten miles from the nearest town of any size, Bedford, and it is realized that much of the success of the venture will depend on the establishment of activities of a social nature within the College itself. There are good facilities for sports and games, and there will be excellent common rooms where staff and students can meet. It is also intended that the library shall contain cultural works as well as scientific and technical literature, since it is recognized that this side of the students' training is of very great importance and that the ability to use language easily and effectively is an enormous asset to the scientific man and the engineer which is often not sufficiently stressed.

The College is really an experiment in itself, for it is endeavouring to treat aeronautical teaching in a new way and has set itself a very high standard. Those who are in the best position to know are convinced that a period of great development in aviation lies immediately ahead, and that it will need no little effort to keep in the forefront of that development. The recent announcement concerning the establishment of a new research centre on a scale hitherto unheard of in Great Britain is a sufficient indication that Britain intends to make the attempt; but such measures would be useless without the *men* who can make them effective. It is here that the new College can be of great service by helping to ensure a flow of highly trained men of science, technicians and designers who will lead the aeronautical world of to-morrow in thought, in research and in practical realization.

THE RUHR COALFIELD AND ITS EXPLOITATION

IT would be unfair to describe the report of a technical mission to the Ruhr Coalfield* merely as a valuable supplement to the well-known Reid Report on coal mining in Great Britain (see *Nature*, 155, 685; 1945), yet this is undoubtedly one purpose of this careful and detailed examination of the best mining practice in the Ruhr. One of the conclusions of the Reid Committee was that "the layout of the Continental mines with straight level roads driven through the strata provided a foundation for the reorganisation of the underground workings", and records of output per man-shift confirm that Ruhr mining methods should prove worthy of study. In 1938, under mining conditions comparable with those prevailing in Great Britain, the Ruhr coal miner produced 30·5 cwt. per man-shift; in the same year the British miner produced 23 cwt. per man-shift.

In the years following the First World War, there was a marked concentration of production in the Ruhr. The policy was that of replacing several coal winding shafts by one centrally situated, resulting in the creation of 'combined mines' with a daily output of 5,000–6,000 tons. By Ruhr standards this is a medium-sized mine, but in Great Britain a similar mine would be regarded as a major unit of production; indeed, there are very few mines in Britain capable of yielding an output of this magnitude. While some degree of concentration is inevitable in Britain, the Ruhr Mission does not recommend, on account of management difficulties, mines as large as the more modern of the Ruhr, which produce as much as 12,000 tons per day.

The inclination of the Ruhr coal seams has led to the development of the horizon system of mining. Briefly, the main development roads are driven in the solid strata, instead of in the coal seams as is the general practice in Britain. Under certain conditions the horizon system has many technical advantages, but most important is the fact that roads can be driven at gradients suited to locomotive haulage. The locomotive is widely used in the Ruhr, and the efficiency of haulage operations is emphasized in the present report. The trolley locomotive—most popular in the Ruhr—is at present barred from British coal mines by the stringent electrical regulations, designed to minimize the risk of explosions of firedamp or coal dust, and accidents due to electric shock. Nevertheless, the Mission recommends that

* Ministry of Fuel and Power and British Intelligence Objectives Sub-Committee. Technical Report on the Ruhr Coalfield. By a Mission from the Mechanisation Advisory Committee of the Ministry of Fuel and Power. (B.I.O.S. Final Report, No. 394.) Vol. 1. Pp. vi+61. (London: H.M. Stationery Office, 1946.) 3*s.* net.

the trolley locomotive should be introduced into British coal mines, under suitable conditions, without delay.

British engineers have for some time been engaged in the development of machines to cut and load coal simultaneously. Machines of a similar type are being used in the Ruhr, but it is found that these are not so far advanced as those of British manufacture. The details of the 'Demag' machine may prove useful to those designing a machine for use in thin seams, and it is recommended that the drawings should be made available to designers in Great Britain. The coal plough, which removes a narrow strip of coal from a longwall face by power, has been the subject of much practical work in the Ruhr, and in the view of the Mission a standard German plough installation should be brought to Britain for trial and investigation; this appliance is a completely new departure in mining technique, and its application in the stronger coal seams of the country may be attended with considerable difficulty. Conveyors of all types have been inspected, and it is stated that Ruhr gate conveyor practice is not up to British standards. However, there are face conveyors of special design which should be brought for trial under British conditions.

Of especial interest to British mining engineers are the methods of mechanical packing practised in the Ruhr. It is universally recognized that the 'goaf' or space left after the extraction of the coal should be wholly or partially packed with debris. To the layman this is apparently a simple problem, and he often expresses a justifiable surprise at the mounting pile of debris to be seen at every pit head. However, the efficient packing of the goaves is a difficult and costly process, absorbing in most British mines a substantial number of workmen, engaged almost entirely in hand packing. Experiments have been made in Britain in mechanical packing, but the Germans have much wider experience of the organisation and equipment necessary for this purpose. For this reason the Mission recommends that the mechanical packing systems of the Ruhr should be applied, under suitable conditions, in British mines.

Ruhr winding practice has clearly reached a high standard of efficiency—a natural development following the centralization of winding arrangements. There are two features of German practice requiring special attention, namely, the Koepe system of winding and the use of skip winders. It is sufficient here to say that the adoption of the Koepe system of winding would be a complete departure from normal British practice, since so far as the present writer is aware there is only one Koepe winder in Britain. Skip winding has proved to be both efficient and reliable in the Ruhr, and there are clear signs that the system is gaining favour in Britain.

The Mission pays high tribute to the excellent arrangements for the co-ordination of development and research. "A striking feature of the Ruhr coal mines is the similarity in equipment and mining practice. This similarity is due in no small measure to the activities of the development and research department of the Bergbau Verein (Coal Owners' Association)." This department was divided into two sections, one dealing with coal production, and the other with coal preparation and chemical matters. Committees were set up for the investigation of specific problems, and these were responsible for the direction of research workers and investigators, who were largely technicians drawn from the industry. Technical institutions and mining schools were also used for certain investigations. The duties of the department ranged over a considerable field, and every suggestion, from whatever quarter, had to receive the fullest inquiry. The German and foreign technical Press was carefully examined, and there is evidence that recent British patents have found application in German mining machinery. It is clear that the industry was well served by this comprehensive organisation, and it is suggested that a similar organisation would be of great value to the British industry.

Government publications on coal mining have been almost exclusively confined to safety and health. There is a paucity of literature relating to the best British and Continental mining practice, and in preparing publications of this type the Ministry of Fuel and Power is making a valuable contribution to the large-scale technical re-organisation which lies ahead of the British mining industry. Tribute must also be paid to the members of the Mission, for their industry in collecting so much information under difficult conditions and in the very short time at their disposal. It is to be regretted that it has not been found possible to publish Volumes 2 and 3 until a later date, particularly since Volume 2 contains the 195 diagrams referred to in the text. All interested in mining technology will look forward to the issue of the further volumes, and will hope that this is the forerunner of many other publications of this type.

H. HARTLEY

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

THE first General Assembly of the International Council of Scientific Unions since the War has just concluded its meetings, which were held at the rooms of the Royal Society, London, under the presidency of Dr. H. R. Kruyt of the University of Utrecht. More than seventy representatives of the principal scientific academies of a number of national research councils and of the various international scientific unions were present. The countries officially represented were Australia, Belgium, Canada, China, Czechoslovakia, Denmark, Egypt, France, Great Britain, India, Italy, Netherlands, Netherlands East Indies, New Zealand, Norway, Peru, South Africa, Sweden, Switzerland, United States and Yugoslavia. In addition, as guests a welcome was extended to M. A. Establier and Mme. Malterre of the International Organisation of Intellectual Co-operation of the League of Nations, and to Dr. J. Needham, head of the Scientific Division of the Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation (UNESCO).

The president in his address mentioned the heavy losses that the Council had suffered by death since its last meeting in 1937. The Executive Committee alone had lost its president, Prof. C. Fabry; two vice-presidents, Il Marchese Marconi, and Baron Joji Sakurai; Prof. H. Abraham (murdered by the Gestapo), General Bourgeois, Sir Arthur Eddington, Prof. Parravano, General Perrier, Dr. Philippson, and Sir Albert Seward, officers of the separate unions which they represented on the Executive Committee.

The president explained the functions of the Council as the international organisation co-ordinating the

national academies and the scientific unions. Its immediate task was to stimulate the formation of unions in branches of science where no union at present existed and to organise scientific activities in those borderland domains which are intermediate between those of two or more unions. The existing committee of the Council on Solar and Terrestrial Relationships provided a good example of what results could be obtained from these intermediate fields of knowledge. It was proposed to make the Committee a joint commission of the Unions of Astronomy, of Geodesy and Geophysics and of Radio Science. New joint commissions and new unions were in view.

There had been discussions with the Scientific Division of the United Nations Educational, Scientific and Cultural Organisation on the possibility of co-operation within their respective fields, and a draft agreement would be submitted to the meeting and referred to the Organisation for ratification later in the year. This new agreement would replace the one officially made in 1937 with the International Organisation of Intellectual Cooperation of the League of Nations with whom for a short time the International Council had had very happy relations. The War had cut right across their schemes for mutual assistance and the agreement had been terminated by notice from the Organisation, which would cease to exist when the United Nations Educational, Scientific and Cultural Organisation came into being.

The Assembly would also be discussing problems arising from the impact of scientific research on the life of the community and also the ethical responsibility of the individual man of science. He hoped that the result of their discussions would be to give this meeting an honourable place in the history of the International Council.

The opening session, after the welcome by Sir Robert Robinson, president of the Royal Society, and Prof. Kruyt's address, was devoted to a general discussion of the future development of the Council's activities and of the policy to be pursued. The general effectiveness of small unions and of large unions with specialized sections or associations was fully discussed; Prof. Kruyt summed up the discussion by saying that the various unions existed to co-ordinate the activities of the scientific workers and that the problem of separation or union could be left to work itself out later.

The second session was devoted to the draft agreement with the United Nations Educational Scientific and Cultural Organisation. As this has not yet been ratified by the Organisation, full details cannot be given; it may be stated, however, that it involves recognition of the several unions and the International Council by the Organisation (and of the Organisation by the Council); close consultative relations between the Council and the Organisation, with at least one liaison officer of the International Council at the headquarters of the Organisation; offers of help from the Organisation to ease the administrative burden that now falls on the secretaries of the Council and unions; assistance, both financial and other, in getting scientific persons to conferences and symposia; and financial assistance in some of the major projects of the unions.

At the third session, reports were read from all the unions, indicating that they had already begun to re-start their pre-war activities, so far as these had necessarily been dropped during recent years, or that they were to hold their initial post-war meetings as soon as proved practicable. On the whole, the reports sounded a more cheerful and hopeful note than had seemed likely in advance; despite the recent difficulties that the unions had been facing, international co-operative work had continued wherever possible and much fresh work was in prospect.

A resolution proposed by Prof. J. Hadamard on the difficulties arising from the restrictions imposed by the exchange control on the free interchange of scientific publications was referred to the Executive Committee for discussion with the United Nations Educational, Scientific and Cultural Organisation.

Amendments of the statutes followed. The more important changes were: (1) the speeding up of the working of the Council by giving to the Executive Committee powers previously kept in the hands of the General Assembly; (2) an increase in the unit of subscription from the adhering countries. This was needed to meet the increased activities called for on the part of the Executive Committee—more frequent meetings and reports.

The fourth session was devoted to the reports of two committees of the Council. Prof. Abetti presented the report of the Committee on Solar and Terrestrial Relationships: the *Quarterly Bulletin of Solar Character Numbers* had now been published up to 1944. Of the present separate character number of the sun only the sunspot number would be given in future bulletins: details of solar eruptions would continue to be published and fresh solar data, especially coronal phenomena now made available by the pioneer work of Lyot.

Prof. J. M. Burgers presented and summarized the report of the Committee on Science and Social Relations. He explained that owing to the difficulties of communication and the short time available to gather in the material asked for by the Executive Committee, there had been no time for discussion by the Committee on Science and Social Relations itself.

A vigorous discussion followed on resolutions submitted by the Committee and an additional resolution proposed by Prof. A. V. Hill. Reference was made in the discussion to the remarks of the president of the Royal Society in his address to the Council at its opening meeting: his final passage may be quoted:

"The prevailing spirit among scientists at the present time should surely be one of hope and optimism. Opportunity knocks at the door. We may well be at a critical point in history the turning of which cannot be accomplished without our assistance. This Council is in a unique position to focus our efforts to maximum intensity and that is why I have ventured to emphasize the necessity for circumspection and the dangers of an attitude of aloofness from the body politic. Wisely used, the most pervasive faith in the world, the religion of the pursuit of truth for its own sake, may be the most potent instrument of reconciliation and reconstruction. Thus we may help to lead the nations into amity and the prosperity which flows from long-continued peace."

In the light of the discussion, the Committee on Science and Social Relations was asked to revise its draft report and, in consultation with the Bureau of the Council, to amend slightly the wording of the resolutions.

At the final meeting, the resolutions as given below were brought forward. Prof. Niels Bohr gave his support, Prof. A. V. Hill quoted Sir Henry Dale as being cordially in favour, and Col. Dianderas approved the resolutions in the name of the government, the universities and the men of science of Peru

and more generally as a representative of South America. The resolutions were adopted unanimously; they are printed below:

1. The General Assembly of the International Council of Scientific Unions sees in the great powers for good or evil that research on nuclear energy has put at the disposal of mankind a supreme opportunity and occasion for a new international unity, to develop the benefits potential in nuclear energy and to avoid its misuse. The General Assembly strongly supports the efforts now being made under the auspices of the United Nations to attain this urgent goal, efforts in which the co-operation of representative men of science, so essential for success, are being officially given. The General Assembly urges that the present opportunity of eliminating war by the attainment of such a new international unity be grasped.

The General Assembly hopes that the attainment of an agreement on the application of nuclear energy may provide an important instance of international co-operation in economic and political matters. Extension of this would facilitate the promotion of the welfare of mankind, the judicious use of our natural resources, the removal of causes of dispute and the settling of difficulties arising from the continuous change of world conditions in consequence of scientific and technical advances.

2. The General Assembly is aware that nuclear energy is not unique among scientific advances in its possible effects for good or ill. Biological and biochemical warfare, for example, were not applied during the late conflict, but their potential menace may be as great as that of the atomic bomb: equally, the discoveries on which they depend could bring the greatest benefits to mankind.

The General Assembly is convinced that international security and welfare will be impossible if, in any country for the future, military secrecy is allowed to dominate scientific discovery or to prevent the frank discussion and open publication of scientific results. There can be no international control and no international co-operation which does not presuppose an international community of knowledge.

3. The General Assembly of the International Council of Scientific Unions, in the name of the men of science of the nations represented, acknowledges the duty on the part of scientific workers:

(*a*) to maintain a spirit of frankness, honesty, integrity and co-operation and to work for international understanding;

(*b*) to promote the development of science in the way most beneficial to mankind and to exert their influence as far as possible to prevent its misuse;

(*c*) to serve the community not only by their specialized work but by assisting so far as they are able in the education of the public in the purposes and achievements of science.

An invitation from the Royal Danish Academy to hold the next meeting of the General Assembly in Copenhagen in 1949 was accepted with acclamation.

The following were elected as the members of the Bureau: *President:* Dr. J. A. Fleming, adviser to the Carnegie Institution in governmental and international scientific relations; *Vice-Presidents:* Prof. B. Němec (Prague), Prof. Emile Borel (Paris); *Members:* Dr. J. N. Mukherjee (New Delhi), Prof. H. Solberg (Oslo); *General Secretary:* Prof. F. J. M. Stratton (Cambridge); *Retiring President:* Dr. H. R. Kruyt (Utrecht).

OBITUARIES

Dr. H. A. Colwell

Dr. H. A. Colwell, who died on July 22 at the age of seventy, was a medical writer of outstanding distinction, especially in the field of radiology. He qualified at St. Bartholomew's Hospital in 1900; later he became M.R.C.P. and submitted a thesis which gained him a Ph.D. at the University of London.

Colwell served as a pathologist in the cancer research laboratories of the Middlesex Hospital for some years; the years 1914–18 saw him serving with the R.A.M.C. in Salonika. He was a fine linguist, and this, combined with a wide range of qualifications in medicine, made him an invaluable officer; at the end of two years service he contracted dysentery and was invalided to Malta. On returning to England he took up work in radiology with Robert Knox, and eventually took charge of the Department of Radiotherapy at King's College Hospital, London.

As an experimentalist he collaborated with Russ on the conversion of starch into dextrin by X-rays, and with Gladstone on the effects of repeated small doses of X-rays upon the chick embryo, a subject with an obvious bearing on X-ray therapy.

Dr. Colwell was a fine writer with the scrupulousness of a scholar, and it is as a writer that he will long be remembered; his chief works were with Russ as co-author. In 1915 they wrote "Radium, X-rays and the Living Cell" at a time when the biological effects of radiations were more and more the subject of experiment, and the book was welcomed by those who were taking the subject of radiology seriously. Nearly twenty years later, the evidence of injuries caused by the radiations was collected in book form and appeared as "X-rays and Radium Injuries". Colwell would talk and write forcibly on the subject of quackery, and he was incensed at its association with radium; at that time people were being induced to drink water charged with radium, to eat chocolate containing radium and to believe that radioactive toilet preparations such as hair restorers, skin lotions and face masks brought special benefits to their users. Colwell's comment was: "One thing about such preparations is quite plain, if they are not radioactive as they claim, they are fraudulent, and if they fulfil that claim, they are dangerous". He published an introduction to the study of X-rays and radium with Wakeley and a delightful book on the history of electrotherapy. His wide knowledge and experience of the subject brought him the Garton Gold Medal and Prize of the British Empire Cancer Campaign for an essay on the "biological effects and mode of action of radiations upon malignant and other cells".

Hector Colwell was at heart a scholar, and no sort of intellectual activity came amiss to him; he was a delightful pianist and a man to whom languages came easily, a quiet retiring man of great charm to those who came within the circle of his friendship. His wife (née Clara Wood) predeceased him in January, and he never recovered from her loss.

Prof. Ernst Freund

With the death on June 2 of Prof. Ernst Freund a great biochemist has passed away. He was a singular scientific personality, whose work did not rest on the results of contemporary research, but always originated from a sudden discovery of new

paths of thought. He had been suffering from ill-health for about a year, but he carried on his research work until his death took place in London.

Freund was born in Vienna in 1863. He graduated as an M.D. at the University of Vienna in 1886. His first publication, "Zur Diagnose des Carcinoms", was published in 1885, when he was still a student. Dissatisfied with the predominantly toxicological and hygienic trend of the type of medical chemistry taught at that time, Freund proceeded in 1890 to found his own biochemical laboratory, which became attached to a large Viennese hospital. Its purpose was to put chemical research at the disposal of the clinics. It was the first biochemical laboratory in Austria, and one of the first of its kind in the world. The importance of this laboratory for the development of biological and clinical chemistry in the old medical centre of Vienna was very great indeed. The results of the activities of his laboratory will be found in many volumes of *Hofmeister's Beitraege*, as well as in the first 255 volumes of the *Biochemische Zeitschrift*.

During this time, Freund's interests were focused on a variety of problems: the isolation of different serum globulins; the role of the intestine in protein metabolism; the presence of albumoses in blood and urine; the composition of urine in infections, especially pneumonia, and in other pathological conditions; the presence of specific nucleo-proteinases in urine; the development of simple methods for the isolation and determination of nitrogen-containing substances in urine, among them of the colloidal fraction of the so-called oxyproteinic acids. The inhibition of blood clotting by keeping the blood in paraffinized vessels was first observed by Freund. He isolated cellulose from miliary tubercles and based a treatment of tuberculosis on the exclusion of cellulose from the diet.

The year 1912 brought a decisive reorientation of Freund's work, which from now on became predominantly connected with cancer research. Jointly with his devoted co-worker, Dr. Gisa Kaminer, he discovered that normal blood serum has the power of dissolving carcinoma cells, whereas blood serum of carcinoma patients does not. Thus the first serological cancer reaction was found. Freund himself linked up his great discovery with yet another concept, that of cancer disposition, and he deduced the possibility of diagnosing cancer in its earliest stages, as well as predisposition to this disease. It is sometimes not realized that Freund's cytolytic reaction is an independent experimental fact which has been confirmed beyond doubt. Freund and his collaborators then proceeded to connect the serological changes with changes in the intestinal bacteriological flora. He tried to control this flora by intestinal disinfection and, above all, by a certain diet, the essential features of which were high protein and low carbohydrate content, complete absence of animal fats, and their replacement by vegetable fats. This diet was tried on animals with experimental cancer as well as on human cases; many inoperable cases showed appreciable, sometimes very great, improvement. Again Freund had broken new ground by demonstrating results the importance of which remains independent of the background of his theory.

At this stage Freund, who had retired from the University, found the interest and powerful support of Mr. Frederick F. A. Pearson, who founded a cancer hospital for dietary treatment of cancer cases, mainly in inoperable stages. During this period Freund also developed new ideas regarding the pathogenesis of rheumatism, which again he linked up with changes in the intestinal flora. With the annexation of Austria, Mr. Pearson transferred his foundation to London, where Freund continued his research work with indefatigable zeal.

Freund's enthusiasm and scientific inspiration was matched by a deep devotion to his humanitarian mission. His modesty and profound kindness added to the fascinating charm of his personality, and it was significant that his co-workers wanted to become also his friends, and his friends to become also his co-workers.

R. WILLHEIM

Prof. J. Uzel

PROF. J. UZEL, professor of agricultural and forest zoology at the Czech Technical College in Prague, died on May 19 at the age of seventy-eight. From childhood he was interested in natural science, and he studied in the faculty of science and philosophy at the Charles University of Prague and at the University of Berlin.

Uzel's chief interest was zoology, especially entomology. His first study was of the group Apterygota. In 1890 he wrote "Šupinušky země České" (Thysanura of Bohemia). For this work he gained an award from the Charles University. Another work on the same group was "Studien über die Entwicklung der Apterygoten Insecten (Berlin, 1898). Meanwhile, as the result of research and careful microscopical observations over a period of years, he produced "Monografie řádu Thysanopter" (a monograph of the order Thysanoptera, 1895). This book, of some five hundred pages, is a fundamental work in this branch of entomology. In it Uzel described many new species of these small, but often serious, agricultural pests. For this book he received an award of the Czech Academy of Sciences.

In 1896 Uzel obtained his doctorate, and then he devoted himself to science and travelling, becoming well known in the scientific world. In 1901 he was invited to Ceylon by Willis, then director of the Royal Botanic Garden in Peradeniya. There he worked as an entomologist for a year. In 1903 the German Government offered him the post of entomologist at the biological station in Amani in Africa. He refused and accepted a position as chief of the research station for the sugar industry in Prague. There he built up a phytopathological department. He took an active part in the protection of sugar beet and published many practical and scientific papers, most of them published in the *Zeitschrift für die Zuckerindustrie in Böhmen*. During the years 1909–10 he was again studying the fauna in the East Indies and Ceylon.

In 1905 Uzel became a lecturer at the Czech Technical College in Prague, in 1909 he was appointed an extraordinary professor of phytopathology, and in 1920 ordinary professor of agricultural zoology and entomology. Not far from Prague he had a biological station, associated with his institute of zoology. For his scientific work Uzel was in 1905 elected to the fellowship of the Czech Royal Society.

In recent years Uzel took up the study of philosophy. He published many papers, and in 1926 a book in Czech, called "Nature is a Gospel" (German edition: Die Natur ein Evangelium, 1937). In this book he gives a summary of his own philosophical

views, which had considerable influence on Czech free religious movements.

During his life Uzel collected at home and abroad much entomological material. This is deposited in the Prague Museum, the Agricultural Museum in Prague, the Natural History Museum in Vienna and in the Museum at Peradeniya. His collections in the Zoological Institute at Prague were destroyed by the Germans during the occupation of the country.

Altogether Uzel published some four hundred papers; a chronological survey of them has been published in Czech: "Work and Life of Prof. Dr. J. Uzel" (Prague, 1938). K. ČERMÁK

WE regret to announce the following deaths:

Mr. G. H. J. Adlam, O.B.E., editor since 1919 of the *School Science Review*, on July 30, aged seventy.

Mr. Asa Binns, formerly chief engineer to the Port of London Authority, and a past president of the Institution of Mechanical Engineers, on July 2, aged seventy-two.

Sir Francis Carnegie, C.B.E., during 1926–44 chief superintendent of ordnance factories, Royal Arsenal, Woolwich, on August 3, aged seventy-two.

Prof. J. Laird, regius professor of moral philosophy in the University of Aberdeen, on August 5, aged fifty-nine.

NEWS and VIEWS

Mathematical Physics at Cambridge: Prof. D. R. Hartree, F.R.S.

PROF. D. R. HARTREE, who has been appointed Plummer professor of mathematical physics in the University of Cambridge, in succession to the late Sir Ralph Fowler, was born in 1897 and educated at Bedales. During the First World War he was a lieutenant in the R.N.V.R., and worked at the Anti-Aircraft Experimental Section at Whale Island as a member of a famous team of scientific men under the direction of Prof. A. V. Hill. Going to Cambridge, he took the Natural Sciences Tripos in 1922 and was elected a fellow of St. John's College in 1924. After one year (1928–29) as University demonstrator in physics, Hartree was elected Beyer professor of applied mathematics in the University of Manchester, which post he held until 1937, when he became professor of theoretical physics in the Physical Laboratory at Manchester.

Prof. Hartree's earlier work was mainly connected with the calculation of the energy-levels and wave-functions of atomic structures. He possesses a great gift and liking for numerical mathematics, and this aptitude he displayed to the full in this field, which he has made peculiarly his own. Later on, when he felt that he had sufficiently exploited 'pencil and paper' methods, he decided that a differential analyser was needed to develop the work further. Taking as a model that of Prof. Bush at the Massachusetts Institute of Technology, a differential analyser was built by Metropolitan-Vickers for Prof. Hartree and housed in the Physical Laboratories, Manchester. This instrument, the first made in Great Britain, has been used for very many other purposes than calculating atomic properties. For example, it has been fully employed during 1939–45 on technical problems for the Services and for industry. During the Second World War, Hartree was employed by the Ministry of Supply on very many problems of importance, particularly in the field of internal ballistics of rockets, of the propagation of radio waves, and of the theory of the magnetron. He was chairman of the Ministry of Supply Panel on servo mechanisms, which has played a very valuable part in co-ordinating work on servo mechanism throughout Great Britain. In 1939 he gave the Kelvin Lecture to the Institution of Electrical Engineers. Recently Hartree's interests in calculating machines have led him to study American work on electronic calculators. He has just returned from a visit to the United States, where he worked at the University of Pennsylvania with the E.N.I.A.C. (see *Nature*, April 20, p. 527). Hartree's appointment to the Cavendish Laboratory will bring him into touch with many fields of physics where his mathematical and computational ability will find full scope.

Bacteriology at the University of Sheffield: Prof. C. P. Beattie

PROF. C. P. BEATTIE has been appointed professor of bacteriology in the University of Sheffield in succession to Prof. Wilson Smith, who recently left the University to occupy the chair of bacteriology at University College Hospital Medical School, London. Prof. Beattie was educated at Fettes College and the University of Edinburgh. After clinical and bacteriological experience in the hospitals and University of Edinburgh, he spent a period of study and research in the United States and in France with a Rockefeller fellowship, returning to Edinburgh to be lecturer in bacteriology in 1933. In 1937 he was appointed professor of bacteriology in the Royal Faculty of Medicine of Iraq and director of the Government Bacteriology Laboratory, Baghdad, which he started and organised as the bacteriological centre for the whole of Iraq, charged with the preparation of protective vaccines and sera as well as the conduct of bacteriological examinations. Prof. Beattie's own researches have covered a wide field of diseases, some common in Great Britain, some peculiar to Iraq; among his many other duties was the setting up of a quarantine laboratory for the examination of pilgrims returning from Mecca. Prof. Beattie will take up his duties at Sheffield at the beginning of October.

Anti-Locust Research Centre

DURING the War, the Anti-Locust Research Centre concentrated on forecasting and advisory services for anti-locust campaigns in Africa and the Middle East; but now a grant for developing research activities has been made under the Colonial Research and Development Act, and Dr. D. L. Gunn, formerly of the University of Birmingham, has been appointed principal scientific officer to take charge of this side of the work. It is hoped that the co-operation of university departments, mainly in zoology, can be enlisted, as funds are available to provide some grants to research students willing to undertake laboratory work on selected problems, or to take part in field investigations abroad, particularly in connexion with

aircraft methods of locust control. Both fundamental problems of locust physiology, behaviour, etc., and the problems of control are in the programme. Workers interested in such problems and heads of university departments who may be able to offer laboratory facilities are invited to write to the Director of the Centre, British Museum (Natural History), London, S.W.7.

Accommodation for Scientific Workers in Danish Laboratories

THE Preparatory Commission of the United Nations Educational, Scientific and Cultural Organisation, 47 Belgrave Square, London, S.W.1, has received from Denmark an offer to accommodate free of charge up to two hundred graduate scientific workers from war-devastated countries in Danish laboratories and technical colleges. The invitation, which is not open to students, applies particularly to graduate scientific workers who, due to the effects of war, are unable to obtain the requisite laboratory facilities in their own countries, whether in Europe, the United Kingdom, China, the Philippines or Iran. All tuition and laboratory fees will be waived for a period up to two years. Travel and living expenses are expected to be met by the visitors' government. In exceptional cases the Danish authorities will consider defraying these expenses also. On a reasonable scale a single person can live for about Kr. 5,000 (about £250) a year in Denmark. The scheme is being sponsored by the Danish Committee for the Training of Foreign Scientists in Danish Laboratories.

Recent Earthquakes

AN earthquake with probable epicentre in the Strait of Georgia 20 miles west of the City of Vancouver and of some severity shook central districts of Vancouver Island on June 23. Buildings, especially in the north and west of Vancouver Island, swayed considerably and some chimneys collapsed. The depth of water in lakes in the interior of Vancouver Island and also the depths of water along the eastern coast of the Island changed considerably. Several beaches became submerged to a depth of 100 ft., and the Canadian Hydrographic Department has ordered the taking of new soundings in the strait for navigational purposes. Dr. E. A. Hodgson has pointed out that there was no immediate aftershock to this earthquake. The earthquake was registered on the seismographs in Switzerland, preliminary pulses arriving at Zurich at 17h. 25m. 05·2s. G.M.T. They were also recorded at Toledo in Spain at 17h. 25m. 13s. G.M.T.

On July 1 an earthquake originated near Fairbanks, Alaska (U.S. Coast and Geodetic Survey), and on July 18 an earthquake at 6h. 07·1m. G.M.T. with aftershock at 7h. 16·5m. G.M.T. had their epicentres at lat. 50° N., long. 129° W., which is in the Pacific Ocean just off Cape Cook (north-west Vancouver Island) and north-west of the earthquake of June 23. The epicentre of the July 18 shock was determined by the U.S. Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association from instrumental readings from fifteen observatories. The depth of focus was estimated to have been rather less than 100 km., which is deeper than normal.

The slight earth tremor which was felt at Leyland in Lancashire about 7 a.m. B.S.T. on July 21 is now believed to have been caused by an explosion in a 100 ft. borehole. Prospecting for oil by seismic means was proceeding. The effect at Leyland was greater than expected for a normal shot.

On August 4 an earthquake of considerable severity originated in the Atlantic Deep, north-west of Puerto Rico. Severe shocks were felt at Puerto Rico, Trinidad, and Ciudad Trujillo on Haiti, and high waves swept into the ports of Matanzas, Puerto Plata, and Ciudad Trujillo. The docks and some ancient churches in this latter city were slightly damaged, and the telephone service was temporarily interrupted at Puerto Rico; but considering the energy of the shock as registered on seismograms throughout the world, surprisingly little damage was done in towns near the epicentre. Strong aftershocks of the earthquake continued at intervals for a week.

Flight Research Section of the Canadian National Research Council

A FLIGHT RESEARCH SECTION of the Division of Mechanical Engineering of the National Research Council is being set up at the Royal Canadian Air Force Station at Arnprior, Ontario. This Section will be financed and operated by the National Research Council. The aerodrome will remain the property of the Department of National Defence for Air, but is leased to the Research Council. The R.C.A.F. will supply flying personnel, aircraft and maintenance staff. Research activities will be under the direction of the National Research Council. It will be a small establishment with probably not more than a hundred men and five aircraft. It is to contain a nucleus of trained flight research personnel and equipment, the object being to do basic research without the interference of normal air traffic. In the laboratories of the Division of Mechanical Engineering of the National Research Council near Ottawa three wind tunnels—two horizontal and one vertical—provide excellent facilities for studies on models of aircraft to determine the probable performance of full-scale aircraft in flight. The Flight Research Section will provide the means of securing necessary additional information to supplement and amplify the results obtained on model tests in the wind tunnel.

Scientific Work in Germany

DR. H. KALMUS, of the Galton Laboratory, University College, London, W.C.1, has received the following information from the French zone of occupation of Germany, in a letter from Prof. Alfred Kühn. Prof. Alfred Kühn left the Zoological Institute in Göttingen in 1937 and went to the Kaiser-Wilhelm Institut für Biologie in Berlin. In the autumn of 1943 he was able to evacuate his department from there to Hechingen, Hohenzollern, and thus all his apparatus and library have been saved. Work in this institution has continued since the occupation first by the Americans and then by the French under the protection of the American T-force and the Mission Scientifique. In December 1945, Prof. Kühn was appointed to the chair of zoology in the University of Tübingen in the French zone of occupation, and he is now trying to move the other biological departments of the Kaiser-Wilhelm Institute to Tübingen. A botanical department under Melchers, working on plant hormones and plant viruses, has provisional quarters in the botanical department of the University. Hartmann and Bauer are working in Hechingen, Hohenzollern, and Hämmerling in Langenargen am Bodensee in

the Institute for Limnology. Prof. Kühn has lost all his close collaborators and is training young workers. His main interest at present is the chemical action of genes; in this work he is collaborating with Prof. Butenandt, who occupies the chair of physiological chemistry in Tübingen.

Study of Photo-elasticity

It has been suggested that a society or association should be formed in Great Britain for men of science and engineers who are interested in the development and applications of photo-elasticity. Such an organisation would enable research workers in this field to keep in touch with each other and, in particular, would provide a common meeting ground for workers in industrial, government and university laboratories. Messrs. H. T. Jessop (Engineering Department, University College, Gower Street, London, W.C.1) and E. K. Frankl (Cambridge University Engineering Department, Trumpington Street, Cambridge) state that it is proposed to arrange a meeting on September 6 at 11 a.m. at University College, London, at which the general character and aims of such a society could be discussed. Communications about the meeting should be sent to Mr. Frankl at the address given above.

Association of Special Libraries and Information Bureaux: Annual Conference

The twenty-first conference of the Association of Special Libraries and Information Bureaux will be held at the Polytechnic, Regent Street, London, W.1, during September 13–15, and a provisional programme has been issued. The presidential address, by Sir Reginald Stradling, will be given on September 14, and the subject is "Special Libraries in Research Organisations". Papers have been promised on the preparation of critical bibliographies (A. D. Roberts, British Library of Political and Economic Science), communication of specialist information to business executives (Prof. R. S. Hutton), mathematical machines and tables (Dr. L. J. Comrie, Scientific Computing Service, Ltd.), and technical dictionaries and glossaries (Miss M. Gosset, Science Library). A symposium on aspects of documentation in Europe has been arranged for September 15 (morning session), at which Mrs. Lancaster-Jones (British Council) will deal with the European demand for British scientific literature, Miss Esther Simpson will speak on the Society for Visiting Scientists, and Ronald Fraser (Control Commission for Germany and Austria) on Germany; information services in other European countries will also be surveyed. Further particulars of the conference can be obtained from the Association of Special Libraries and Information Bureaux, 52 Bloomsbury Street, London, W.C.1.

University of London Appointments

The following appointments in the University of London have been announced: Dr. S. E. Hollingworth, a senior geologist in H.M. Geological Survey, to the Yates-Goldsmid chair of geology tenable at University College, as from October 1; and Dr. Ronald Hare, of the Connaught Laboratories, University of Toronto, to the University chair of bacteriology tenable at St. Thomas's Hospital Medical School, as from October 1.

The following titles, in respect of the posts indicated, have been conferred: Mr. W. R. Spurrell, Guy's Hospital Medical School, to be professor of physiology in the university; Dr. L. E. Bayliss, University College, to be reader in physiology in the University; Dr. S. J. De Navasquez, Guy's Hospital Medical School, to be reader in pathology in the University; Dr. R. W. B. Pearce, Imperial College of Science and Technology, to be reader in spectroscopy in the University; Dr. R. J. V. Pulvertaft, Westminster Hospital Medical School, to be professor of clinical pathology in the University; Dr. W. D. Wright, Imperial College of Science and Technology, to be reader in colour vision in the University; Dr. C. E. Wynn-Williams, Imperial College of Science and Technology, to be reader in physics in the University.

Karel Preis (1846–1916)

Although not widely known outside Central Europe, Karel Preis contributed to the advance of two sciences, founded a sugar research station and a now famous technical museum. His parents were French, probably settling in Bohemia as young refugees during the Napoleonic wars. At one time his father had a wine business in Prague, where Karel was born on August 20, 1846. After studying chemistry and other sciences at the Polytechnic, Preis was eventually made a professor there in 1868. In his small analytical laboratory he engaged upon a series of minor researches, and one of his earliest discoveries related to a double sulphide of iron and potassium, K_2S,FeS, which he made by heating sulphur, reduced iron and potassium carbonate together to bright redness. Ten years later (1879), together with B. Rayman, he studied the action of nitric acid on cholesterol and cholesteryl chloride, and in 1884 they prepared and examined the bromides of tin. They isolated a number of derivatives and studied the reactions of the tin halides with water, ammonia and other substances. In addition to these researches, Preis wrote a number of textbooks and trained many successful technical chemists, particularly for the sugar industry. He was editor of the *Chemické Listy* for twenty years and of the sugar journal, *Listy Cukrovarnické*, for thirty-three years. Moreover, Preis was a keen naturalist and collector of insects; he wrote a monograph on Czech Hymenoptera.

Announcements

Prof. Arthur Holmes, regius professor of geology in the University of Edinburgh, has been elected a corresponding member of the Geological Society of Belgium, in recognition of his important contributions to geological science.

Prof. H. S. Raper, since 1923 Brackenbury professor of physiology and director of the Physiological Laboratories in the University of Manchester, has been appointed dean of the Medical School and professor of chemical physiology in the University. Dr. W. Schlapp, reader in experimental physiology and assistant director of the Physiological Laboratories, has been appointed to the Brackenbury chair and to the directorship of the Physiological Laboratories.

Erratum. The ordinates of the graph accompanying the communication entitled "Effect of *p*H in the Dye Titration of Vitamin C in Certain Plant Materials" by Dr. F. Wokes in *Nature* of July 27, p. 133, should read "100, 75, 50, 25" and not "10, 7, 5, 2" as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fluctuations in Cosmic Radiation at Radio-Frequencies

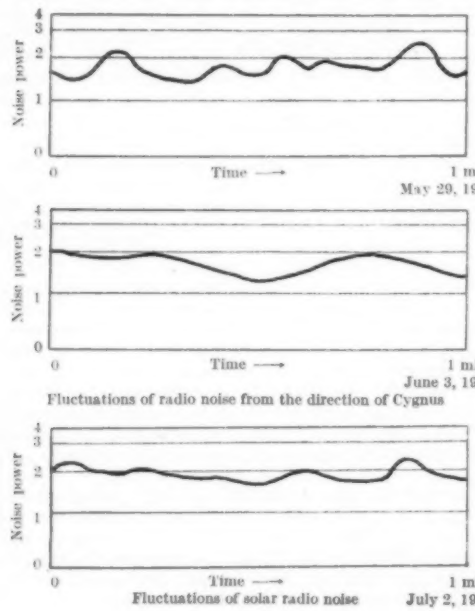
In a previous publication[1] we described the results of an investigation into the spatial distribution of cosmic electromagnetic noise radiation at 5 metres wave-length. We have recently been engaged in an attempt to make a more detailed determination by using a more sensitive receiver of narrower beam-width. An interesting new feature which has emerged from these latter experiments is the occurrence of short-period irregular fluctuations which have been found to be associated with the direction of Cygnus. This region, which is a secondary peak in the cosmic noise distribution, appears to be unique in being characterized by short-period variations of marked amplitude in the intensity of power flux.

A watch on this region has been kept intermittently during the last four months. The receiving apparatus, situated in Richmond Park, has an aerial beam rotatable in bearing but fixed in elevation at an angle of 12°. The region of the fluctuations ascended and descended through the aerial beam on bearings 30° and 330° respectively. The corresponding times were 0100 hr. and 1900 hr. G.M.T. in February, when the watch was commenced, while in June they were 1800 hr. and 1200 hr. G.M.T. Care was taken to avoid including recordings taken in daylight periods when the powerful solar noise emission associated with the great sunspot in February was also present. Since the observations covered a wide range of bearings and solar times, we were able to rule out the possibilities of terrestrial or solar causes, and the interpretation of the results was consistent only with an origin in the direction of Cygnus.

It is not easy to determine the bearing of a source of irregular disturbance with a high order of accuracy unless an exceptionally narrow beam is used. The aerial of the equipment has a beam width of approximately ± 6° to half power in bearing and elevation, and the average of a large number of observations indicated a source of disturbance subtending an angle not exceeding 2°. There may be other areas of occasional fluctuation in the immediate vicinity (within 8°).

The average amplitude of the fluctuation is 15 per cent of the mean power received. If the disturbed area be assumed to extend over a circle of angular diameter 2°, then this solid angle is 1/36 of that for the equivalent acceptance cone of the aerial beam. The variations in power per unit solid angle therefore correspond to more than five times the mean power per unit solid angle for the whole beam. The centre of the region is approximately R.A. 2000 hr., Decl. + 43°. The type of fluctuation, which itself varies from day to day, is illustrated in the accompanying figure. The noise from Sagittarius would, by comparison, appear as a straight line on a diagram of this scale.

It appears probable that such marked variations could only originate from a small number of discrete sources. This suggests at once the analogy with the radio-frequency sunspot radiation[2,3,4]. The solar radio noise from sunspots is also characterized by strong fluctuations. A recording of these solar radiations, taken on July 2, is also shown in the figure. On the other hand, Greenstein, Henyey and Keenan[5] have recently pointed out the difficulties in attempting to account for the magnitude of cosmic radiations in terms of the solar phenomena; further, they direct attention to the close agreement between experimental observations of cosmic noise intensity and their calculations of the expected interstellar radiation arising from free transitions of electrons in the field of protons. A theory in terms of widely distributed interstellar matter does not, however, appear readily to account for the localized disturbances just described. These fluctuations therefore appear of special importance in that they may prove particularly relevant to the explanation of the origin of cosmic radiations at radio frequencies.



Fluctuations of radio noise from the direction of Cygnus

Fluctuations of solar radio noise

We are indebted to the Director General of Scientific Research and Development (Defence), Ministry of Supply, for permission to publish this communication.

J. S. Hey
S. J. Parsons
J. W. Phillips

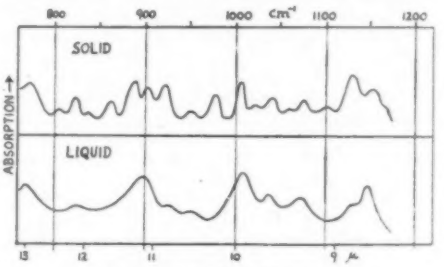
Ministry of Supply.
July 4.

[1] Hey, Parsons and Phillips, *Nature*, **157**, 296 (1946).
[2] Appleton, *Nature*, **156**, 534 (1945).
[3] Hey, *Nature*, **157**, 47 (1946).
[4] Pawsey, Payne-Scott and McCready, *Nature*, **157**, 158 (1946).
[5] Greenstein, Henyey and Keenan, *Nature*, **157**, 805 (1946).

Infra-Red Spectra and State of Aggregation

Recent work in this Laboratory has shown that the infra-red spectrum of a substance may differ markedly according to the particular state of aggregation—gas, liquid or solid—in which it is measured[1]. The interpretation of such changes has become especially significant in connexion with the correlation of spectra with molecular structure, particularly when dealing with polymers, resins and plastics; but the principles underlying the phenomenon are of fundamental importance and must involve a consideration of the degree of molecular order in the different states of aggregation.

In order to examine this phenomenon in greater detail, a survey is being made of the spectra of some simple molecules as solids and liquids. With polar substances the spectral differences found are not surprising, but they have also been found with a number of non-polar substances. For example, there are marked changes in the case of 3-ethyl tetracosane, the spectra of which between 8–13 μ are shown. It should be noted that not only do new bands appear with the solid, but there are some differences in relative intensity of bands in the two states, even though the frequencies may be little affected.



Spectra of 3-ethyl tetracosane

The extent to which the spectrum is affected by the change of state varies with the particular molecule concerned, and with branched paraffins, for example, appears to depend upon the extent and positions of branching. Similar measurements have recently been described by Halford and Schaeffer[2] with benzene, and substantially the general conclusions drawn by them appear to apply to results found for other hydrocarbons. As pointed out in an earlier paper[1], the passage from one physical state to another will involve a change in both the potential energy function of the system and of the selection rules, and with a long branched paraffin chain the frequencies and intensities of the bands may be expected to change.

Further examples of this phenomenon will be considered in detail later.

H. W. Thompson

Physical Chemistry Laboratory,
Oxford.
July 13.

[1] Thompson, H. W., and Torkington, P., *Trans. Farad. Soc.*, **41**, 259 260 (1945); *Proc. Roy. Soc.*, A, **184**, 15 (1946).
[2] Halford, R. S., and Schaeffer, O. A., *J. Chem Phys.*, **14**, 141 (1946). Halford, R. S., *J. Chem Phys.*, **14**, 8 (1946).

High-Frequency Resistance of Superconductors

Measurements by H. London[1] on the heating of superconducting tin by high-frequency electromagnetic fields indicate the presence in the superconductor of some mechanism which enables it to absorb a measurable quantity of energy from the field provided the frequency is of the order of 1,000 Mc./sec. or more. Recent developments in radio technique have made it possible to employ a resonance method to investigate the effect, and this communication describes preliminary work at frequencies around 1,200 Mc./sec., corresponding to a free-space wave-length of 25 cm. The specimens were polycrystalline thin wires contained in quartz capillary tubes for rigidity, bent into a narrow U

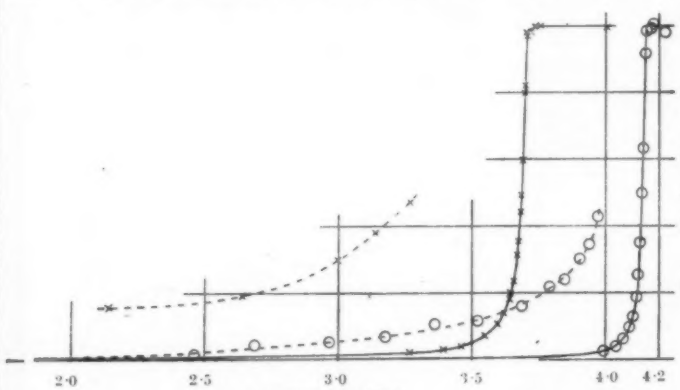
to form a twin transmission line roughly a quarter wave-length long, and surrounded, to eliminate radiation losses, by a cylindrical sheath, which was either silver-plated or lined with lead-foil to minimize resistive losses. Measurements of the width of the resonance curve of the system by a controlled variation of the oscillator frequency gave a value for the skin resistance of the specimen.

The accompanying graph shows the skin resistance R of tin and mercury, relative to its value R_n for the normal metal just above the transition point; as a function of temperature. The shape of the curve for tin is in good agreement with London's published curve, measured at the slightly different frequency of 1,500 Mc./sec.; there are no previous results with which to compare the curve for mercury. For both metals the curves appear to tend to zero at 0° K., though there is some uncertainty in the values of the skin resistance at the lowest temperatures, due to dielectric loss in the quartz, which limits the Q of the resonator to about 250,000. By comparing the results for two wires of different diameter, the dielectric loss may be estimated, and the curves here shown have been corrected for this effect as well as possible.

The absolute skin resistance of the specimen may be determined from the Q and the geometry of the resonator, and from this, by application of the standard theory of the skin effect, the specific conductivity of the metal can be deduced. The value obtained for normal tin at 3·8° K. was $2{\cdot}1 \pm 0{\cdot}2 \times 10^7$ ohm.$^{-1}$ cm.$^{-1}$ (the large probable error arises from the approximations used in performing the calculation rather than from the measurements, which were consistent within 1 per cent); a D.C. measurement of the specific conductivity gave 15×10^8 ohm^{-1} cm.$^{-1}$, more than seven times as great. A discrepancy of the same magnitude was noted by London. For mercury the effect is not so pronounced, the specific conductivity as deduced from the radio-frequency measurements being $0{\cdot}92 \times 10^7$, compared with the D.C. value[2] of $2{\cdot}1 \times 10^7$.

Although the shape of the specimen was not very suitable, an attempt was made to discover whether the skin resistance was affected by the presence of a constant magnetic field. Up to one half the critical field, no variation of skin resistance was detected, which by London's theory (see below) may be interpreted as evidence for the constancy of the penetration depth in small fields. No useful readings could be taken in stronger fields, since a portion of the specimen passed into the intermediate state.

The variation of the skin resistance of mercury with temperature is particularly interesting, since with the aid of London's[1] theory of the effect it is possible to deduce the variation with temperature of the penetration depth λ, which has been studied for mercury more directly by other methods; it is, however, too much to expect agreement with these other results, since they do not agree among themselves. Appleyard and his collaborators[3], from the properties of thin films, and Shoenberg[4], by measurements on colloids, found an increase in λ as the critical temperature is approached from below, whereas



○——○, mercury, R/R_n; ○- - -○, mercury, $R/R_n \times 20$;
×——×, tin, R/R_n; ×- - -×, tin, $R/R_n \times 20$

Casimir[5], using a mutual inductance method with macroscopic specimens, found no such change. In order to apply London's theory to the radio-frequency measurements, it is necessary to assume only one parameter λ_0, the penetration depth at 0° K. Taking $\lambda_0 = 1{\cdot}0 \times 10^{-5}$ cm., as found by Appleyard *et al.*, the value of λ at any other temperature may be calculated to agree within 10 per cent with Appleyard's figures. It would be unwise to regard this agreement as very significant, in view of the assumptions involved in London's theory, which need to be tested by an extensive investigation of the behaviour of both normal metals and superconductors over a wide range of temperatures and frequencies.

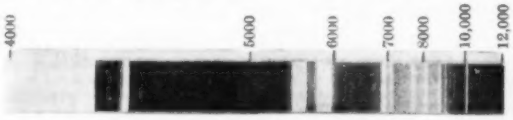
A. B. PIPPARD

Royal Society Mond Laboratory,
Cambridge.
July 22.

[1] London, H., *Proc. Roy. Soc.*, A, **176**, 522 (1940).
[2] Kamerlingh Onnes and Tuyn, "Intern. Crit. Tables", **6**, 124 (1929).
[3] Appleyard, Bristow, London, H., and Misener, *Proc. Roy. Soc.*, A, 172, 540 (1939).
[4] Shoenberg, *Proc. Roy. Soc.*, A, **175**, 49 (1940).
[5] Casimir, *Leid. Comm.*, 261, c (1940).

Investigations of Near Infra-Red Radiations by Means of Image Converters

FOR rapid examinations of near infra-red light up to 15,000 A., image converters are very useful. Their main advantage lies in enabling one to 'see' immediately what infra-red sensitized plates show only after involved processing. The spectrum under test is projected on to a photo-electric cathode of the type (Ag) — Cs_2O, Cs, Ag — Cs. The number of photo-electrons released is proportional to the intensity of radiation on that particular part of the cathode: they are focused by an electronic lens and form a picture on the fluorescent screen, which can either be studied visually or photographed. The accompanying illustration shows a photograph (× 1·5) of the mercury spectrum. In addition to the visible lines a number of lines in the near infra-red part of the spectrum have appeared. On the original photographic plate we can also see some lines of longer wave-length, which cannot be seen on the reproduction.



It should be mentioned that the converter used had a convex cathode, so that only a part of the image could be focused; but it appears probable that, with an improved apparatus of this type, a number of important problems could be attacked.

A. VASKO

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July 6.

Long Wave-length Absorption Bands of Aromatic Molecules

CALCULATIONS of the long wave-length absorption bands of aromatic molecules, such as those carried out by Sklar[1] and Förster[2], give good agreement with the experimental values of absorption maxima even when only nearest-neighbour exchange effects are taken into account (as in Förster's work). In these calculations, it almost always happens that the lowest two totally symmetric levels (of which the ground-state is one) are separated by an unsymmetric level, and the transition to this from the ground-state is permitted in molecules having, at most, twofold axes of symmetry: experimentally, the long-wave absorptions of these molecules have intensities compatible with an allowed transition—anthracene, for example, has $\varepsilon_{max.}$ of about 10^4.

Phenanthrene, however, provides an interesting departure from this usual situation. Here the energy-level calculation shows that there is no unsymmetric level between the ground-state and the lowest excited symmetric level, and consequently the transition of lowest energy is one between levels of the same symmetry. The usual symmetry considerations show that the transition moment for such a change will be very small and will lie along the axis of symmetry of the molecule. In fact, the absorption of phenanthrene does show a weak long wave-length absorption between 3000 A. and 3600 A., having its centre at about 3400 A., and with $\varepsilon_{max.}$ about 300. This band is comparable in intensity with the forbidden A_{1g}–B_{3u} transition in benzene (2600 A.) and is, apparently, to be associated with the symmetric-symmetric transition discussed above. Förster associated his calculated value of 3000 A. with the strong phenanthrene band at 2950 A.; it now appears that it should be assigned to the 3400 A. weak band, and that the 2950 A. band is due to a symmetric-unsymmetric transition of higher energy. The poor agreement between the calculated and experimental values for the forbidden transition is connected with the fact that Förster's empirical exchange integral was estimated as an average for a number of inter-symmetry transitions and is too large for a symmetric-symmetric change.

The above assignment receives confirmation from the fact that the 3400 A. band is greatly increased in intensity (× 10) when the C_2v symmetry is destroyed by the substitution of a nitrogen atom for a carbon atom, to give the skew benzquinolines. The situation is in marked contrast to the anthracene-acridine-benz-*g*-quinoline case where the transition moment (this is an allowed transition) is scarcely altered when the symmetry is lowered.

Further details, together with some related work, will be published soon.

D. P. CRAIG

Department of Chemistry,
University of Sydney.
July 10.

[1] Sklar, A. L., *J. Chem. Phys.*, **5**, 669 (1937).
[2] Förster, Th., *Z. Elektrochem.*, **45**, 548 (1939).

Mathematics in Government Service and Industry

In an article in *Nature* of May 4, p. 571, Mr. John Todd and Mr. D. H. Sadler expressed the view that training in numerical methods should be given to mathematical students at the post-graduate level. The chief reason given was that their experience had shown that a knowledge of the more advanced parts of mathematics often becomes a powerful tool in the hands of the computer. The object of this note is to direct attention to an example which arose recently in connexion with my research work, providing additional evidence for their views.

In the course of a certain investigation, it was necessary to tabulate the function given by the doubly infinite series,

$$\sum_{r=1}^{\infty}\sum_{s=1}^{\infty}\frac{\sin\,(2r-1)\pi\alpha/a\,.\sin\,(2s-1)\pi\beta/b}{(2r-1)\,(2s-1)\,[(2r-1)^2b^2+(2s-1)^2a^2]} \qquad (1)$$

where $a = 160$, $b = 60$ for a range of values of α and β given by $\alpha = 5{\cdot}0, 6{\cdot}0, 7{\cdot}0, 8{\cdot}0, 9{\cdot}0, 10{\cdot}0$; $\beta = 0{\cdot}6, 0{\cdot}7, 0{\cdot}8, 0{\cdot}9, 1{\cdot}0, 1{\cdot}1$.

Consider the direct computation from (1) for the values $\alpha = 5{\cdot}0$, $\beta = 0{\cdot}6$. After considerable numerical computation, it was shown that the sum of the first hundred terms of the doubly infinite series (corresponding to $1 \leqslant r \leqslant 10$, $1 \leqslant s \leqslant 10$) evaluated to 3·528. However, the series converged so slowly that even with this amount of laborious calculation little accuracy could be expected.

It may be shown, however, by a method the details of which I hope to publish elsewhere, that one of the double series may be summed, and the expression reduces to

$$\pi/4a^2\sum_{s=1}^{\infty}\frac{\sin\,(2s-1)\pi\beta/b}{(2s-1)^3}\,[1-\cosh\,(2s-1)\pi\alpha/b$$

$$+\coth\,(2s-1)\pi a/b\,.\sinh\,(2s-1)\pi\alpha/b-\sinh\,(2s-1)\pi\alpha/b\,.\operatorname{cosech}\,(2s-1)\pi a/b] \qquad (2)$$

Moreover, for the given values of a and b, correct to at least five places of decimals, $\coth\,(2s-1)\pi a/b$ is equal to unity. With this simplification, the expression may be shown to reduce to

$$\frac{\pi^4\beta}{32a^2b}\left[1-\beta/b\right]-\frac{\pi}{4a^2}\sum_{s=1}^{\infty}\frac{\sin\,(2s-1)\pi\beta/b\,.\exp\,[-(2s-1)\pi\alpha/b]}{(2s-1)^3} \qquad . \quad . \quad . \quad (3)$$

I have been unable to complete the summation contained in (3), but the series converges sufficiently rapidly for a good approximation to be obtained from consideration of the first ten terms. For the particular case $\alpha = 5{\cdot}0$, $\beta = 0{\cdot}6$, expression (3) gives a value 3·92 which differs appreciably from the value 3·528 found by the much more laborious method of direct computation. As it was required to evaluate the expression for the range of values of α and β, the total time saved was considerable.

This example shows that a knowledge of the more advanced parts of mathematics may be extremely useful in problems of numerical computation, and confirms the views previously expressed that training in numerical methods suitable for candidates proposing to make a career in the Scientific Civil Service should be given at the post-graduate level.

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June 25.

Combustion of Carbon and Carbon Monoxide

The recent observation of Arthur[1], who found that the $CO/(CO + CO_2)$ ratio in the products of combustion of carbon in air at 800° C. was greatly increased by addition of chlorine or its compounds, is extended by results obtained in these laboratories during the past six months. We have worked at 800°–1,000° C. with undried gases, and find that:

(i) In the combustion with air of 18-in. deep beds of 1 mm. particles of coke in a 1-in. silica tube, the $CO/(CO + CO_2)$ ratio in the exit gas is increased by the addition of small amounts of chlorine, hydrogen chloride, or carbon tetrachloride to the air. Thus at 1,000° C. and with an inlet total gas rate of 200 litres/hr., sufficient to expand the bed of coke particles to a voidage of 0·7 so that the whole bed was agitated, the exit gas analyses (not quenched) were

% Vol.	Carbon tetrachloride	Carbon dioxide	Oxygen	Carbon monoxide	$CO/(CO + CO_2) \times 100$
	Nil	16·8	Nil	4·8	22·0
By	0·2	13·0	0·8	10·4	44·0
Orsat.	0·4	9·6	0·2	17·0	64·0
	2·0	3·2	0·2	29·5	90·0

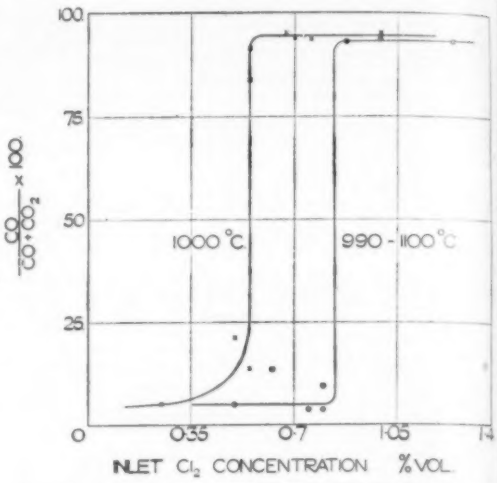
The 3·2 per cent carbon dioxide in the table probably contained nearly 2 per cent free chlorine. The temperature was measured by a thermocouple placed in the centre of the tube, 2–4 in. from the top of the coke.

(ii) The above effect is not due to catalysis of

$$CO_2 + C \rightarrow 2CO,$$

since no change in gas composition occurs when chlorine is added to carbon dioxide passed through coke under the same conditions.

(iii) In the combustion of 10 per cent carbon monoxide in air plus nitrogen mixtures (O_2/CO ratio = 1) over 18 in. of silica chips in a 1-in. silica tube, almost complete inhibition can be obtained by addition of chlorine. At any temperature there is a critical chlorine concentration at which inhibition sets in (see graph). This critical concentration increases with temperature, and for a given concentration of inhibitor there is a critical temperature above which no inhibition occurs.



All the chlorine is not found as such in the product gases when inhibition is occurring, and there are indications that only the excess chlorine above the critical concentration for inhibition appears in the exit.

An interesting aspect is an inhibition-temperature hysteresis effect. Starting with a carbon monoxide air mixture containing chlorine slightly less than its critical concentration, it is found that inhibition commences and becomes complete on lowering the temperature, but does not cease when the temperature is then raised above that at which it commenced. Inhibition ceases, however, if the flow of the inhibitor is momentarily interrupted.

Both this hysteresis effect and the critical chlorine concentrations effect can be explained on a chain-theory basis[2,3], assuming the inhibiting action of chlorine is due to combination with an active link in the chain process. Lowering the temperature reduces the degree of chain branching until the inhibitor present is equivalent to the active links when oxidation ceases and inhibition is complete; but once inhibition has started, combustion cannot occur even at higher temperature as the inhibitor is present in sufficient quantity to prevent the initiation of the process before branching (and therefore combustion) can begin. The residual carbon dioxide in the inhibited oxidation gases (0·5–0·7 per cent carbon dioxide), which is shown in the graph by the non-achievement of 100 per cent inhibition, may be significant, as it has possibly been formed by the direct non-chain oxidation of carbon monoxide.

Applying these observations on the oxidation of carbon monoxide to the earlier work on coke combustion some conclusions can be drawn. The very low carbon dioxide content of the gases produced by the inhibited combustion of coke would suggest that carbon dioxide is not formed as a primary product in the oxidation of carbon at 1,000° C., the monoxide being the first gas formed, which in normal (uninhibited) combustion processes is immediately oxidized to the dioxide in the voids of the bed. This secondary carbon monoxide oxidation reaction does not occur when the inhibitor is present. From other experiments, it is apparent that the effect of the voidage of the bed on the combustion reaction is considerable. Working with a highly expanded bed (under conditions somewhat similar to those in Chukhanov's experiments[4,5] with a suspension of carbon in air) a gas is produced with a low CO/CO_2 ratio, while with a bed of smaller voidage the carbon monoxide content is increased at the expense of the dioxide, at least partly due to an increase in the extent to which the dioxide reduction reaction can take place. This suggests that the character of the combustion gas is controlled to a very large extent by conditions in the bed above the combustion zone, where the reduction of carbon dioxide is the predominating reaction, rather than in the combustion zone itself[6,7,8].

It is hoped to give an account of these and further experiments to the Society of Chemical Industry at Newcastle early in 1947.

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Research Department,
Billingham Division,
Imperial Chemical Industries, Ltd.
July 15.

[1] Arthur, *Nature*, **157**, 733 (1946).
[2] Cf. Semenoff, "Chemical Kinetics and Chain Reactions" (Oxford University Press).
[3] Cf. Hinshelwood, "Kinetics of Chemical Change in Gaseous Systems" (Oxford University Press).
[4] Chukhanov, *J. Tech. Phys. U.S.S.R.*, **8**, 511 (1938). (See *Fuel*, **18**, 292.)
[5] Karshavina, *Tech. Phys. U.S.S.R.* (*Eng.*), 633 (1938). (See *Fuel*, **19**, 220.)
[6] Bangham and Bennett, *Fuel*, **19**, 95.
[7] Hiles and Mott, *Fuel*, **23**, 134 and 154.
[8] Thring, *Trans. Farad. Soc.*, **42**, 366 (1946).

Heat of Sublimation of Carbon

Long and Norrish emphasize in a recent communication[1] the importance of the tetravalent ^5S state of the carbon atom from the point of view of organic chemistry, stating that neglect to distinguish between divalent and tetravalent atomic states of carbon is mainly responsible for the apparent state of confusion characterizing at present the thermochemistry of carbon. It may be mentioned that Schmid and Gerö take a similar view in the thermochemical interpretation of their results concerning the spectrum of CO, when they deduce 170 kcal./gm.-atom as the heat of sublimation into ^5S atomic states of carbon[2].

According to the dissociation scheme given by Schmid and Gerö, the energy distance of the $X^1\Sigma$ ground state of CO from the $C(^5S) + O(^3P)$ atomic term combination is 11·06 eV. (with the original conversion factors), and this energy value is to be taken into account in thermochemical calculations involving tetravalent carbon compounds, or in determining the heat of sublimation of carbon. In CO, carbon is divalent, the ground-state dissociating accordingly into an atomic term combination corresponding to a carbon state of the s^2p^2 configuration, probably into $C(^1D) + O(^1D)$, the bond energy of CO ($X^1\Sigma$) being in this case 10·1 eV., while for the energy distance of the CO ground-state from the lowest $C(^3P) + O(^3P)$ atomic term combination gives 6·89 eV. Unfortunately, these results have often been misunderstood, in calculating the heat of sublimation of carbon from this last dissociation energy value, whereas the heat of sublimation of carbon is connected with the value corresponding to carbon atoms in the ^5S state. The spectroscopic value 170 kcal. is in excellent agreement with the dynamic sublimation heat value resulting from the rate of loss in weight of heated carbon filaments, while the lower value resulting from an equilibrium measurement in the carbon arc can be interpreted by a statistical equilibrium between C atoms and C_3 molecules[3].

Meanwhile, several authors have arrived at the conclusion that the heat of sublimation of carbon should be 170 kcal. Thermochemical considerations of White[4], the reconciliation of some kinetic and thermochemical data by Baughan[4], the conclusions of Kynch and Penney[5] from absorption bands of mesomeric hydrocarbons, and the recent note of Sidgwick and Springall[6] concerning the Hg—C bond all point in this direction. According to the interpretation of Schmid and Gerö, the corresponding conclusions can be maintained or suitably reinterpreted in taking into account that the organic compounds dealt with are built up from tetravalent ^5S atoms, and the bond energies are to be calculated from an energy value corresponding to the ^5S term of carbon.

Against the dissociation scheme of CO given by Schmid and Gerö, Herzberg puts first of all as a theoretical argument the non-crossing of the energy curves of the two-centre problem, and applies this argument also to the sublimation of carbon in deducing the formation of '^3P carbon atoms'. But as can be shown[7], the conclusions resulting with respect to the energy curves of the two-centre model cannot be transferred to the potential curves of the vibrating and rotating molecule, the electronic motion (the averaging with respect to which of the interactions between all the particles leads to the potential curve determining the motion of the nuclei) also being influenced through the interaction by the motion of the nuclei. The co-ordination of Schmid and Gerö is supported by a large number of arguments in their paper, among the more recent results being an observed predissociation limit at 8·83 eV.[8], and the convergence of the $I^1\Sigma$ state to 10·1 eV.[9]. According to still unpublished calculations of Gerö, the resulting value of the heat of sublimation of carbon can give a satisfactory account of a great variety of thermochemical data of organic compounds.

J. G. Valatin

Institute of Experimental Physics,
Hungarian University for Technical
and Economic Sciences,
Budapest. May 6.

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[2] Schmid, R., and Gerö, L., *Z. phys. Chem.*, B, **36**, 105 (1937).
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[4] Baughan, E. C., *Nature*, **147**, 542 (1941).
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While agreeing with our emphasis of the significance of the ^5S state of carbon for the calculation of bond energies in its compounds, Valatin, from an analysis of the CO spectrum proposed by Schmid and Gerö, implies alternative numerical values to the quantities which we have termed L_1 and L_2', and for which we have proposed the values 125 and ~ 190 kcal./gm.-atom respectively. The scheme quoted by Valatin would mean in effect that $L_1 = \sim 73$ kcal. and $L_2 = 170$ kcal., values which are in serious conflict with other relevant data. It should be emphasized that, since more than one interpretation may be devised for the CO spectrum, spectroscopic arguments alone lead to no conclusive value for $D(CO)$ and hence L_1. Only a consideration of the spectroscopic data with all the evidence available from other sources will allow a final selection to be made.

Direct or indirect measurements of the vapour pressure of graphite by both the equilibrium and dynamic methods have, in the past, led to varying results for the heat of sublimation, some as high as 200 kcal. or more. In general, the determination of the vapour pressure under equilibrium conditions provides considerably lower figures for the heat of sublimation than does the dynamic method; and the equilibrium method alone (after a statistical allowance for the pressure of C_3 molecules has been made) is capable of providing a direct measure of L_1. Whereas some determinations, in particular the approximate equilibrium measurements of Thiel and Ritter[2] and Basset[3], have indicated values for L_1 so low as about 125 kcal., none has provided values appreciably lower than this figure. For conditions under which true equilibria have been established, equilibrium concentrations of both free carbon atoms in their ground (^3P) state and C_3 molecules must be considered, and we do not regard as justifiable Schmid and Gerö's effectual neglect of the ^3P atomic state in carbon vapour[4] in their discussion on the results furnished by the equilibrium method. The precise value of $D(C_3)$ is unfortunately not settled: whereas one estimate places it so low as 83 kcal./mol., it may be so high as 150 kcal., but could scarcely be appreciably higher than this figure.

The theoretical total vapour pressure values for carbon with the intermediate assignment $D(C_3) = 125$ kcal. have been calculated by Goldfinger and Jeunehomme[5]. The highest reasonable assumption regarding $D(C_3)$ could not reconcile the observed pressures with a value of L_1 much below 125 kcal., and since these authors further demonstrate that even $L_1 = 107$ kcal. necessitates a vapour pressure much too high to be a likely value, it is still more difficult to accept the much lower value (~ 73 kcal.) implied by Schmid and Gerö's analysis, which requires vapour pressures several powers of ten greater than have ever been observed. Furthermore, the low value 6·9 eV. for $D(CO)$, from which this figure is derived, finds no place in the empirical relationship for similar diatomic molecules observed by Barrow[6], which necessitates a dissociation energy for CO in the neighbourhood of 9 eV.

From the point of view of bond energies, L_2 is by far the more interesting quantity. Theoretical considerations[7] have led to the expectation that the mean bond energy in the methyl radical is slightly greater than in methane. From the heat of formation of methane, the dissociation energy of H_2, and the energy required to remove a hydrogen atom from the methane molecule[8], it can be shown that the mean bond energy in CH_3 will exceed that in CH_4 only if $L_2 > 182$ kcal. This, and other considerations regarding the relative energies of reorganisation of methyl and ethyl radicals on their formation from methane and ethane respectively, lead us to ~ 190 kcal. for L_2. This figure is also to be preferred from the calculation of the heat of sublimation (177 kcal.) by the dynamic method[9], since it would follow from the arguments of Herzberg[10] that this method provides only a lower limit for L_2.

That the inferred figure, ~ 65 kcal., for the difference between L_2 and L_1, that is, the excitation energy of ^5S carbon, is to be preferred to the value ~ 97 kcal. (favoured by Schmid and Gerö) is strongly indicated by three independent lines of thermochemical evidence which are discussed at length in our forthcoming paper[11]. These include experimental data regarding the stability of the formyl radical, which place an upper limit of about 75 kcal. on the C: ^5S excitation energy. In accord with this, a calculation by Ufford[12] places this excitation energy at ~ 73 kcal.

L. H. Long
R. G. W. Norrish

Laboratory of Physical Chemistry,
Cambridge. July 12.

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[2] Thiel, A., and Ritter, F., *Z. anorg. Chem.*, **132**, 125 (1923).
[3] Basset, J., *J. Phys. Radium*, vii, **10**, 217 (1939).
[4] Schmid, R., and Gerö, L., *Z. phys. Chem.*, B, **36**, 105 (1937).
[5] Goldfinger, P., and Jeunehomme, W., *Trans. Farad. Soc.*, **32**, 1591 (1936).
[6] Barrow, R. F., *Trans. Farad. Soc.*, **36**, 1053 (1940).
[7] Van Vleck, J. H., *J. Chem. Phys.*, **2**, 20 (1934).
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[10] Herzberg, G., *Chem. Rev.*, **20**, 145 (1937).
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A 'New' Human Blood Group Antigen of Frequent Occurrence

The sera of two women, whose babies were suspected of suffering from hæmolytic disease of the new-born, were recently found to contain identical agglutinins of a variety not previously described. The serological examination of the two families is at present incomplete, but there is so far no definite evidence in either case that the agglutinin concerned is the result of immunization of the mother by the fœtus. Indeed, the red cells of one of the jaundiced babies were not agglutinated by its mother's serum: this points towards the agglutinin being spontaneous rather than immune.

The antibodies are active at 37° C.; they appear slightly stronger at room temperature: at 10° their effects are masked in both cases by strong non-specific cold agglutinins. Both the women are of group *O* and the *α*- and *β*-agglutinins are difficult to absorb from the sera without diluting out or removing most of the 'new' agglutinin. Hence nearly all examinations have been carried out on group *O* red cells.

Out of 96 group *O* bloods of English people, mostly unselected but some selected for their *Rh* type, 24 (or 25 per cent) are agglutinated. Reactions are mostly well-defined positive and negative; one doubtful result has been eliminated from this count, and it is possible in view of the weakness of the antibodies that some positives have been missed.

The 'new' agglutinogen has been shown to be independent serologically of the *ABO*, *MN*, *Rh*, *P* and Lutheran[1] systems. It is also independent of the 'Kell' system, which was shown to be responsible for a case of hæmolytic disease of the new-born—case No. 14 of Coombs, Mourant and Race[2]. By kind permission of Mrs. H. D. G. Lewis, who has the 'new' antibody, and of her husband, the name 'Lewis' is proposed for the antigen.

Fifteen families have been studied from the point of view of the inheritance of the agglutinogen. In seven cases both parents of a Lewis-positive person have been examined. In every case at least one of them is also positive. This is conclusive evidence that the agglutinogen is inherited, and suggestive, but not statistically significant, evidence that it is a Mendelian dominant character rather than a recessive. No evidence has yet been found of genetic linkage with other blood group antigens.

Cells agglutinated by the antibody form characteristic large rather loose masses. Lewis-positive cells which have been treated with a barely agglutinating dose of antibody and washed are not agglutinated by anti-human-globulin serum[3]. The antibody thus differs from the *Rh* antibodies and apparently resembles in this respect the iso-agglutinins α and β [4].

I should like to acknowledge the assistance which I have received from Mr. R. Hudson of the N.E. London Blood Supply Depot, Luton, who first found and directed my attention to these antibodies, and from Dr. R. R. Race. A full account of the investigation will be published elsewhere.

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Combined Action upon Muscle of Adenosine Triphosphate, Acetylcholine and Potassium, Calcium and Magnesium Ions

In a note published in *Nature* in 1944, Buchtal and Kahlson[1] have pointed out that the close intra-arterial injection of 5 μgm. acetylcholine after introduction of adenosine triphosphate increases the intensity and duration of the mechanical response of muscle. The combined action of these substances is of considerable interest, in view of the important part taken by adenine triphosphate in muscular contraction and of the participation of acetylcholine in the transmission of impulses at the myoneural junction.

Our experiments have been carried out with the dorsal muscle of the leech and the m. rectus abdominis of the frog. The muscles were placed in Ringer solution of the following composition: sodium chloride, 6·0 gm.; potassium chloride, 0·14 gm.; calcium chloride, 0·06–0·1 gm.; sodium bicarbonate, 0·1 gm.; and water, 1 litre. The sodium salt of adenosine triphosphate was prepared immediately before the experiment and used in concentrations of 1×10^{-2} – 1×10^{-4} with frog muscles and in concentrations of 2×10^{-4} – 1×10^{-6} with dorsal leech muscles.

It was found that these concentrations of adenosine triphosphate did not by themselves produce any contraction of the m. rectus abdominis of the frog, and they led to small contractile response of the leech muscle. After one application of the adenosine triphosphate solution the frog and leech muscles react to solutions of acetylcholine with contractions of increased intensity. The contractions remain increased when the solution of acetylcholine is applied several times. It follows that adenosine triphosphate sensitizes the muscle to acetylcholine. The initial smaller contractile effect of acetylcholine is restored only after repeated washing of the muscle with Ringer solution.

In another series of experiments, we investigated the contractile response of muscle to the action of adenosine triphosphate and acetylcholine in different ionic media.

These experiments were undertaken in view of the fact that potassium, calcium and magnesium ions influence the activity of adenosine-triphosphatase[5–8] and the contraction of myosin threads[6,7]. According to these data, calcium ions activate adenosine triphosphatase, thereby promoting its breakdown, and potassium and magnesium ions inhibit adenosine triphosphatase, thereby counteracting the breakdown of adenosine triphosphate. On the other hand, it has been shown that the contraction of myosin threads produced by adenosine triphosphate in the presence of potassium chloride is inhibited by calcium ions and increased by potassium and magnesium ions.

To determine the effect of changed ionic environment we have used Ringer solution with increased contents of calcium chloride (up to 0·3 gm. in 1 l.) or of potassium chloride (up to 0·28 gm. in 1 l.); in some experiments magnesium chloride was added to the Ringer solution (0·1 gm. to 1 l.). The increased concentration of potassium ions leads to a markedly increased reaction to acetylcholine of muscles subjected to the action of adenosine triphosphate. This increased sensitivity to acetylcholine persists longer than in normal Ringer solution. The same effect is obtained in the presence of magnesium ions.

The opposite effect was observed under the influence of calcium ions. When their concentration in the solution is increased, adenosine triphosphate does not cause contraction of the dorsal muscle of the leech; sensibilization to acetylcholine was also absent, and the muscle was less responsive to it. Both in the frog muscle and in that of the leech adenosine triphosphate produces no contraction in Ringer solution with increased content of calcium, and leads to a persistent decrease of the contractile response to acetylcholine.

Our data on the action of potassium, magnesium and calcium ions upon the contractile response of muscle produced by adenosine triphosphate coincide with the results obtained by Szent-Györgyi and Erdös with myosin threads. They show that the action of ions upon adenosine triphosphatase and their action upon contractility of muscle are two separate and not directly parallel processes.

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Role of Thiamin and Riboflavin in the Biosynthesis of Vitamin C

The rat is known to synthesize vitamin C in the course of its normal metabolism. It has been observed by Longenecker and associates[1] that this synthesis can be greatly stimulated, resulting in the high urinary excretion of the vitamin, when the rats are given daily a variety of compounds, particularly narcotics. In view of the great variation in the nature and constitution of the effective compounds, these authors are inclined to the view that these substances act as promoters rather than precursors for the synthesis of the vitamin. They were not able to suggest, however, any probable mechanism for this biosynthesis of vitamin C by narcotized rats.

It has been observed by us that narcotics such as chloretone stimulate the synthesis of vitamin C in rats without significantly affecting urinary sugar, nitrogen and phosphorus, blood sugar and phosphorus and liver glycogen. Injection of intermediary metabolites such as pyruvate, lactate, etc., into rats has no effect on the synthesis. The process has also been found to be independent of certain endocrine factors, as the excretion under the narcotic remains unaffected by adrenalectomy or pancreatectomy.

Different dehydrogenase systems such as citric, glutamic, glycerophosphoric, succinic, lactic and pyruvic, present in rat tissues, have been studied by the methylene blue technique. It has been observed that pyruvic and lactic dehydrogenases are affected in the chloretonized condition of the animals. The effect of chloretone on the aerobic and anaerobic oxidation of pyruvate by brain tissue of the rat under normal and narcotized conditions of the animals has been studied by the Warburg manometer and by the ferricyanide technique of Quastel *et al.*[2] respectively. A definite inhibition of pyruvic acid oxidation has been observed under aerobic condition, the effect being far less pronounced in the anaerobic state. This seems to indicate, as also suggested by Michaelis *et al.*[3], that chloretone exerts its main effect on that part of the system which is responsible for the oxidation of pyruvic acid under aerobic condition, and not on the components capable of oxidizing it anaerobically.

Following up this study further, it has been observed that the stimulating effect of chloretone on the biosynthesis of vitamin C by the rat and the consequent urinary excretion of the vitamin can be almost completely suppressed, if the animals are made thiamin-deficient. This stimulating effect can be restored to the deficient animals by thiamin therapy. The effect of inanition for one day each week, the sparing action of fat on thiamin and the possibility of vitamin C being destroyed during the abnormal state of vitamin B_1-deficiency of the rats have also been considered. It has been observed that the stimulating influence of chloretone on the synthesis of vitamin C by the rat is not affected by these conditions of the animals. It appears therefore that thiamin has some specific role in the synthesis of vitamin C by the rats under chloretone, and that the inhibition of pyruvic acid oxidation by the narcotic is very probably also a factor involved in the process.

It has further been found that the stimulating effect of chloretone on the synthesis of vitamin C and its urinary excretion by the rats can also be greatly suppressed if the animals are made riboflavin-deficient. The excretion of the vitamin can be restored to the original level by administering riboflavin to the deficient rats. It has also been shown by the paired feeding technique that inanition does not affect the role of riboflavin in this synthesis of ascorbic acid by chloretonized rats.

Barron *et al.*[4] have shown that thiamin or its phosphorylated form diphosphothiamin is closely associated with pyruvic acid metabolism in the living organism. Ball[5] has presented evidence for a scheme of pyruvic acid metabolism in which both thiamin pyrophosphate and flavoprotein are involved. From the present work it would appear that if pyruvic acid is transformed into ascorbic acid in the narcotized rat, this process also requires the participation of thiamin and riboflavin.

Our thanks are due to Dr. S. Banerjee for the surgical operation of some animals in connexion with the investigation. We are also indebted to the Indian Research Fund Association for a grant. Grateful acknowledgment is also made to Messrs. Hoffmann-La Roche, New Jersey, for the gift of the vitamins used in this work.

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Production of Potent Botulinum Toxins and Formol-Toxoids

The preparation of suitable botulinus vaccines requires the production of toxin of great potency and high antitoxin combining power. The process of detoxication with formalin is facilitated if the medium is low in inactive proteinaceous substances. One of us (A. P.) suggested growing botulinus in 'Cellophane' bags filled with saline and immersed in meat broth (broth with meat particles). The bacilli grew readily in the bags and gave a very high yield of toxin. 'Cellophane' bags that contained nutrient broth instead of saline gave little toxin.

A 'D' type strain grown in saline in 'Cellophane' bags gave a culture of which 10^{-4} c.c. killed a mouse. The Lf and L+ were about eighty times those found with cultures grown in the ordinary way. The filtrate was readily detoxicated in 7–10 days with 0·5 per cent formalin, as against the three weeks needed by toxoid cultures made in meat

broth, even when 0·8 per cent formalin was used. The loss in antigenicity during preparation of the toxoid (measured by flocculation) was about half that usually found.

Guinea pigs immunized with a single dose of 1/40 c.c. of the new toxoid showed after a month a mean serum titre of 80 laboratory units. This compares with an average of 20 units obtained by immunization with 0·5 c.c. of ordinary toxoid. In practice, 0·5–1 unit of circulating antitoxin adequately protects a bovine against natural botulism (lamsiekte).

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Cyclic Variations of the Submicroscopic Structure of the Cortical Layer of Fertilized and Parthenogenetic Sea Urchin Eggs

The cortical layer of the unfertilized egg of *Psammechinus miliaris* exhibits a remarkable positive birefringence (with respect to the radial axis) which has been interpreted as meaning that the cortical layer is built up of radially arranged lipid molecules[1,2]. The birefringence disappears at fertilization and reappears during the anaphase of the first mitosis[2]. This means that the cortical layer undergoes rhythmic variations of its submicroscopic structure. We have investigated the cycle of such structural variations in relation to the phases of mitosis and to the modifications of permeability occurring during the early stages of development, in both fertilized and parthenogenetic eggs.

Birefringence totally disappears immediately after fertilization as well as after butyric acid treatment. It reappears, in both cases, about 10–15 min. later ($t° = 15°$–$18°$), but rather faintly and inconstantly. Between 15–20 min. and 50 min. after activation, the cortical layer is isotropic. It shows again a beautiful and very brilliant positive birefringence with polarization cross, from 50 min. to 1 hr. after activation, corresponding to the ana-telophase of the first mitosis in the fertilized eggs and to maximum expansion of the monaster in the parthenogenetic eggs.

Later on, the birefringence disappears when the first cleavage begins, and the monaster in the parthenogenetic eggs is undergoing reduction. At about 1 hr. 30 min., the cortical layer again shows birefringence, corresponding to the ana-telophase of the second division and to the expansion of the second monaster cycle.

The question arises whether the rhythm of the structural variations of the cortical layer is dependent upon the spindle cycle. Colchicine treatment, which inhibits spindle formation as well as the appearance of the spermaster in fertilized eggs and of the monaster in parthenogenesis, does not alter the rhythm of birefringence. Thus the birefringence cycle, although normally synchronous with spindle and monaster expansion, is entirely independent of them.

Two types of plasmolysis have been described in the fertilized and parthenogenetic eggs, following treatment with hypertonic sea water, indicating different physical conditions of the cortical layer: a 'smooth' and an 'angular' plasmolysis[4]. In the first case the egg contracts, preserving its spherical form; whereas in the second it acquires a wrinkled surface. We found that smooth plasmolysis occurs when the cortical layer shows birefringence (both in normal and in colchicine treated eggs); angular plasmolysis corresponds exactly to the phases of absence of birefringence.

A discussion of these findings will be published later in a more extensive paper.

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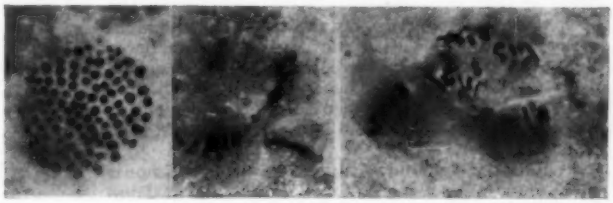
A Decaploid Strain of *Artemia salina*

On March 8, 1946, Dr. M. Levy, a chemist in the Palestine Potash Company at the north end of the Dead Sea, handed us a number of living specimens of the brine shrimp (*Artemia salina*) which he had found in abundance in the salt-washing pans of the potash works. In these pans the salt residue of Dead Sea water is washed out by admitting fresh water from the Jordan. This water gradually increases in salinity, but the various ions are represented in this solution in proportions differing from those of Dead Sea water. Especially, the magnesium concentration is relatively much lower than in the Dead Sea. At the time of collecting, the specific gravity of the water measured at 20° C. was 1·173 (potassium chloride 4·2, sodium chloride 22·0, calcium chloride and magnesium chloride 37·2 gm./l.; total of chlorine, 165 gm./l.).

It must be assumed that we have here an invasion of *Artemia* into a relatively new artificially produced biotope. The specific gravity of the water in this new locality is higher than that of the most concentrated solutions in which Gross[1] was able to keep his brine shrimp. On transferring the animals into Dead Sea water, they were found to survive no longer than six hours. *Artemia* is known to occur in Palestine at a distance of some 120 km., in the marine salt pans of Atlit, near Haifa.

Some of the animals, which were exclusively parthenogenetic females, were fixed in Carnoy's fluid. The chromosome number was determined as usual, in metaphase plates of the first oocytes. Of five specimens so far examined, one showed 107, two 108 and two 109 tetrads. Since the basic haploid number of *Artemia salina* is known to be 21, the present race must be considered as decaploid with a slight augmentation of the number of 105 tetrads. This deviation from the expected number may be interpreted in two possible ways. On one hand, there may be two to four supernumerary chromosomes fluctuating in the population. On the other hand, the deviation from the number of 105 tetrads may be due to failure of prophase pairing in some homologues. We might be dealing with 103 tetrads and 4 dyads, or with 102 tetrads and 6 dyads, or with 101 tetrads and 8 dyads. It is not impossible that polysomy and failure of pairing may be jointly responsible for the abnormal numbers observed. It should be noted that wherever details could be distinguished, the metaphase figures presented the aspect of tetrads. Among the specimens investigated, several had been fixed immediately after their arrival in the laboratory, others had been kept up to six weeks in various concentrations of Mediterranean sea water.



1 2 3

Fig. 1. First oocyte, Dead Sea strain, metaphase plate. 109 tetrads. Heidenhain's Hx. × *c.* 1250

Fig. 2. Multipolar first cleavage figure parthenogenetic egg, Dead Sea strain. In accordance with the three centres present, the chromosomes have become arranged in a triradiate figure. Heidenhain's Hx. × *c.* 950

Fig. 3. First cleavage figure, parthenogenetic egg, Dead Sea strain. Owing to the presence of four centres, a complicated multipolar spindle is formed, the left-hand part of which is seen in side view, the right-hand part in equatorial view. Heidenhain's Hx. × *c.* 1100

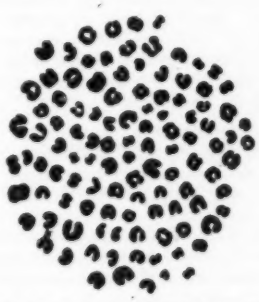


Fig. 1*a*. Camera lucida drawing of plate shown in Fig. 1. × *c.* 2400

Of a culture of parthenogenetic female brine shrimps collected in Atlit and kept for several years in the laboratory, some animals were fixed for comparison. In two of the individuals examined so far we have found 64 tetrads, a number which may be interpreted as hexaploid increased by one supernumerary pair.

Peculiar irregularities were observed in the first cleavage divisions of the Dead Sea strain. Owing to the formation of multipolar and quite irregular spindles, the chromosomes arrange themselves in equatorial plates at various angles to one another and appear to become distributed at random to the first blastomeres. The formation of these multipolar spindles may be caused by the abnormally high concentration of one or several of the ions present in the brine in which the strain was found. It might also be correlated with the exceptionally high grade of polyploidy, which is the highest so far found in Artemia[2].

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ARE HYDRANGEA FLOWERS UNIQUE?

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APART from *Meconopsis betonicifolia* and *Hydrangea macrophylla*, no plant has been recorded as displaying a flower colour change, caused by varying soil conditions. That such a plant might exist is a possibility depending on three conditions[1,2]: (1) it must have a delphinidin flower pigment which in an acid cell sap is normally pink but is blue in the presence of excess aluminium; (2) it must be able to accumulate aluminium; this is a specific characteristic manifest only when sufficient is available, for example, in acid soils; (3) it must have a wide range or reaction tolerance. Many plants fulfil the first condition but invariably fail the rest. If a blue-flowered plant could be found that also accumulates aluminium, then there is a possibility that if such a plant could be grown in a neutral or slightly alkaline soil and so be unable to accumulate this element, a change of flower colour from blue to pink would take place.

Of the fifty-eight flowering plants hitherto known with certainty to accumulate aluminium in large amounts[3,4,5] none has blue flowers, but royal blue pigmentation does occur in the fruit of certain species of the well-known aluminium plant family, Symplocaceæ. In an examination for the presence of excess aluminium in several other blue-fruiting calcifuges, those hardy in Britain gave negative results[3]; but all except one, in Trinidad, provided they were dicotyledonous, gave highly positive results. Many common species of Melastomaceæ (not known to me at the time to be an aluminium-accumulating family) and Rubiaceæ with ultramarine fruits proved very strong aluminium-accumulators. To date, fifty-five blue-fruited dicotyledons have been found to give positive aluminium reactions. These belong to the following genera:

Symplocaceæ	3 Symplocos*[4].
Melastomaceæ	1 Leandra*, 3 Platycentrum*, 6 Clidemia*, 2 Conostegia[4], 9 Miconia*[3], 2 Ossea*, 1 Memecylon*[4].
Rubiaceæ	4 Coccocypselum*, 2 Faramea*, 7 Cephælis*, 10 Psychotria, 1 Palicourea*, 1 Rudgea*, 2 Saprosma*, 1 Lasianthus[4].

An examination of all the available members of the last two families disclosed that the capacity to accumulate aluminium is, so far as can be ascertained, most strongly developed in the more advanced of the woody tribes, namely, the Coussareæ and Psychotrieæ in the Rubiaceæ and the Miconiæ and Memecylieæ of the Melastomaceæ. Other genera, hitherto not known to be aluminium-accumulating, are: Meriana*, Mecranium*, Heterotrichum, Chrianthus, Tetrazygia, Blakea, Henriettea*, Henrietella, Necrameum, Mouriria*, Coussarea, Declieuxia*, Chasalia*, Cœlospermum*, Borreria.

Those genera marked with an asterisk have given highly positive aluminium reactions in practically all of the species tested and thus might safely be regarded as wholly aluminium-accumulating under favourable conditions. To date, 173 new aluminium-accumulating plants have been discovered out of 417 species qualitatively tested in Trinidad, and possibly 3,000 more, if all the species of proved genera (including many untested blue-fruited species) are taken into account.

The qualitative test is, briefly: about one square inch of crushed leaf material, placed in a test-tube with about one c.c. of 'Aluminon' reagent, is heated for five minutes in a boiling water bath. A deep red colour indicated an aluminium accumulator with more than 1,000 p.p.m. in the dry material. The reagent[3], which is quite stable for many months, consists of 0·75 gm. 'Aluminon', 200 gm. ammonium acetate, 15 gm. gum acacia, 189 ml. concentrated hydrochloric acid, dissolved separately, mixed and made up to 1,500 ml. This buffered and stabilized reagent was also used in quantitative determinations of aluminium. In the accompanying table, data are presented to illustrate the range of aluminium concentration in some of the plants mentioned here.

	Aluminium, p.p.m. dry leaves	Where grown
Blue fruits		
Miconia nervosa (Sm.) Tr.	9,160	Trinidad
Symplocos cratægoides Ham.	6,560	England
Coccocypselum guianense (Aubl.) K. Sch.	5,810	Trinidad
" " (fruit)	1,810	"
Faramea axillaris Standl.	32,100	Peru
Cephælis tomentosa Willd.	9,950	Trinidad
Psychotria brachiata Sw.	15,400	Trinidad
Palicourea vestita Standl.	9,100	Costa Rica
Rudgea fusticoides Standl.	36,800	Peru
Memecylon Arnottianum Wight	> 10,000	Ceylon
Blue fruits and blue flowers		
Faramea eurycarpa Donn. Smith	35,000	Costa Rica
F. rectinervia Standl.	16,000	Peru
Psychotria Herzogii S. Moore	22,600	Bolivia
Blue flowers		
Hydrangea macrophylla DC.	13,000	Trinidad
" " (pink flowering)	60	England
Faramea anisocalyx P. and E.	36,900	Peru
F. insignis Standl.	40,000	Colombia
Palicourea amethystina (R. and P.) DC.	11,800	Peru
P. nigricans Krause	17,100	Peru
Memecylon polyanthemos Hook	> 10,000	W. Africa
Mean for 26 calcifuges of non-accumulating families[3]	206	England

The cell sap acidity range of aluminium plants was shown[3] to be *p*H 4·3–5·5, with the largest proportion of species at *p*H 4·3–4·6. Tests on 40 Trinidad species extended the range to *p*H 3·6 and the distribution was greatest at *p*H 3·6–4·0. Over these acidities the normal colours for delphinidin pigments are red but the delphinidin-aluminium lakes are blue. This was readily demonstrated by macerating petals or berries with a series of buffer solutions. The blue fruits of *Cephælis tomentosa* and *Psychotria brachiata* were still blue at *p*H 3·6 and changed to purple at *p*H 3·4. Normal delphinidin pigments in the pink hydrangea or the blue forget-me-not were red over this range, but on adding a drop of dilute aluminium sulphate solution they turned sky-blue.

During the search in the available floras[6–11] for blue-fruited plants it was found that some were also blue-flowering and that many other members of the same genera were blue-flowering although not blue-fruiting, and a few of the latter were even known to have flowers varying from blue to pink. These were just the plants that would be likely to fulfil the requirements for the hydrangea phenomenon. The blue-flowering aluminium plants disclosed are as follows: 2 *Cephælis*, 5 *Psychotria*, 16 *Memecylon*, 26 *Faramea* and 26 *Palicourea*. Variable flowers are those of: *Palicourea alpina*, *P. angustifolia*, *P. heterochroma*, *P. lasiantha*, *P. nigricans* and *P. pulchra*. Closest to *Hydrangea macrophylla* in showiness is *Faramea anisocalyx*, which has blue flowers and spectacular sky-blue bracts. These bracts have been noted by collectors in Peru as being sometimes pink. Whether this colour-variability is due to soil differences is not known; but it is a probability. Attempts will be made to obtain seeds of this attrac-

tive plant in order to grow it under conditions of high and low soil acidity.

The unique nature of hydrangea flowers is now questionable from the evidence submitted above; cultural tests will give the final answer. This investigation is being continued with further plant material, generously supplied by the Chicago Natural History Museum and the British Museum (N.H.).

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RELATIONS BETWEEN THE SOURCE OF NITROGEN AND ANTIBIOTIC FORMATION BY *ASPERGILLUS FUMIGATUS*, FRESENIUS

By R. RAGHUNANDANA RAO and P. R. VENKATARAMAN

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MANY papers have been published on the antagonism of certain micro-organisms against acid-fast bacteria, particularly *M. tuberculosis*[1-13]. In this connexion the metabolic products of the various strains of the group *Aspergillus* are receiving considerable attention. Fumigatin[14], spinulosin[15], helvolic acid[16] and gliotoxin[17] are the four metabolic products of *A. fumigatus* which show considerable antibiotic activity. The present communication relates to a study of the formation of antibiotic activity and the source of nitrogen by *A. fumigatus*, Fresenius. The strain of this organism was obtained from the Imperial Institute of Agricultural Research, New Delhi, isolated by Mr. G. Smith of the London School of Tropical Medicine.

A. Inorganic and Organic Sources of Nitrogen

In the place of sodium nitrate of Czapek-Dox medium, inorganic and organic sources of nitrogen were used, so that the media contained the same amount of nitrogen as in Czapek-Dox medium (33 mgm. of nitrogen per 100 c.c.). To these modified media, sodium chloride was added, the sodium ion concentration being the same as in the Czapek-Dox medium.

Bacteriological test-tubes 15 cm. long and 1·7 cm. in diameter containing 5 c.c. of the medium were sterilized at 15 lb. pressure for half an hour and inoculated with a spore-suspension of the organism. The tubes were then placed in a slanting position, at an angle of about 20–30° to the horizontal, so as to furnish large surface for growth, and incubated at 28° C. (mean). Duplicate tubes from each group were removed at intervals of 24 hours and the antibiotic activity determined, according to Foster and Woodruff[18], using *B. subtilis* as the test organism. The reactions of the media were also recorded. The initial *p*H of the media in all cases before inoculation with spore-suspension was adjusted to *p*H 4·3, unless otherwise stated. The results are presented in Table 1.

TABLE 1

Source of nitrogen	*p*H	Growth characteristics	Antibiotic activity
1. Sodium nitrate	*p*H slowly rose, becoming alkaline on the fifteenth day	Growth was observed on the third day, as white surface mat, which was complete on the seventh day and had few spores.	Activity on the fifth day only (*p*H 5·8). Halo-diameter 12 mm.
2. Ammonium chloride	*p*H 3·4 on the second day after inoculation and did not change further.	Growth was observed on the second day. Surface mat full of blue spores was complete on the fifth day.	No activity.
3. Ammonium sulphate	do.	do.	do.
4. Ammonium nitrate	do.	do.	do.
5. Urea	do.	Growth was observed on the second day. Surface mat with spores being complete on the third day.	do.
6. Glycine	do.	do.	do.
7. Aspargine	do.	do.	do.

From these results it is clear that the Czapek-Dox medium favours the formation of the antibiotic, with simultaneous shift in the *p*H of the medium to the alkaline side. With the other sources of nitrogen, no antibiotic activity is detectable and the *p*H of the media becomes more acidic. Evidently these sources of nitrogen favour the formation of acids by the organism.

B. Complex Nitrogen Sources

We have utilized enzymic digest of groundnut cake, supplemented with minerals, and wheat bran as sources of nitrogen under this group.

(1) The preparation of the enzymic digest of groundnut cake is described by Rao and Venkataraman[19]. The ratio of the total nitrogen to the amino nitrogen (complex) in the digest is 4·75. The experimental procedure outlined in *A* was employed for growing the organism and testing the antibiotic activity of culture fluids. The results are summarized in Table 2.

The unsupplemented groundnut cake hydrolysate favours the formation of maximum antibiotic activity on the third day. With rise in the *p*H of the medium, the activity slowly decreases from the fourth day onwards. The addition of the constituents of the Czapek-Dox medium without sodium nitrate to the hydrolysate seems to have no significant influence on the antibiotic formation. However, the addition of 0·5 per cent sodium chloride or 2 per cent sodium acetate to the groundnut cake hydrolysate seems to exert a stabilizing influence on the antibiotic. A similar observation has been made by Cook *et al.*[20] on the stabilizing influence of sodium chloride in the production of penicillin using fractions obtained from the aqueous extracts of pea.

(2) 5 gm. of wheat bran contained in 250 c.c. conical flasks were moistened with 10 c.c. of water and mixed well. The flasks were plugged and auto-

TABLE 2

Composition of media	1 Groundnut cake hydrolysate alone. Total solids adjusted to 2 per cent	2 Groundnut cake hydrolysate (total solids 2%) + Czapek-Dox minerals and glucose, but no sodium nitrate	3 Groundnut cake hydrolysate (total solids 2 %)+0·5% sodium chloride	4 Groundnut cake hydrolysate (total solids 2%) + 2% sodium acetate
Initial *p*H	4·3	4·3	4·3	7·2
First day after inoculation				
(*a*)	+	−	−	+
(*b*)	4·4	4·4	4·4	7·2
(*c*)	Nil	Nil	Nil	Nil
Second day after inoculation				
(*a*)	+	+	+	
(*b*)	5·1	4·7	5·3	
(*c*)	Nil	Nil	Nil	
Third day after inoculation				
(*a*)	+	++	+	+
(*b*)	7·2	5·3	7·2	7·3
(*c*)	14·5	Nil	14·5	12·0
Fourth day after inoculation				
(*a*)	++	++	+	+
(*b*)	7·5	7·2	7·6	7·4
(*c*)	11·5	14·5	13·5	16·0
Fifth day after inoculation				
(*a*)	++	++	+	++
(*b*)	7·7	7·5	7·7	7·6
(*c*)	11·0	11·5	13·5	16·0
Sixth day after inoculation				
(*a*)	++	++	++	++
(*b*)	8·0	7·7	8·0	7·8
(*c*)	11·0	11·0	11·5	11·0
Seventh day after inoculation				
(*a*)	++	++	++	++
(*b*)	8·1	8·0	8·2	8·0
(*c*)	10·5	11·0	11·0	10·5
Eighth day after inoculation				
(*a*)	++	++	++	
(*b*)	8·1	8·1	8·2	
(*c*)	9·5	9·5	9·5	

(*a*) Growth characteristics: − indicates no growth, + indicates growth without spores, ++ indicates growth with spores; (*b*) *p*H of the culture filtrate; (*c*) Activity (mean halo-diameters in mm.).

claved at 15 lb. pressure for half an hour. The sterile moist wheat bran was then inoculated with a spore-suspension of the organism and incubated at 28° C. At intervals of 24 hours one flask was removed, 10 c.c. of sterile water was added, mixed well and contents pressed through cloth. The antibiotic activity of the pressed liquid was determined. From the results presented in Table 3 it is obvious that the maximum antibiotic activity is reached on the fifth day.

TABLE 3

Days after inoculation	Growth characteristics	Antibiotic activity (mean halo-diameter in mm.)
1	No growth	Nil
2	White surface growth, no spores	Diffused halo
3	Thick mat, blue spores	11·0 mm.
4	do.	11·0
5	do.	15·0
6	do.	13·0
7	do.	12·0
8	do.	11·0
9	do.	10·5

From the set of experiments in Table 3 we may conclude that *A. fumigatus*, Fresenius seems to utilize preferentially complex sources of nitrogen for the production of antibiotic. Experiments are in progress for the concentration and isolation of the metabolic products of the organism when grown on groundnut cake hydrolysate in presence of sodium ions. Results of these and other related investigations will be published elsewhere.

Our thanks are due to Prof. V. Subrahmanyan and Drs. N. N. De and K. P. Menon for their kind interest in the work. We acknowledge the generous support of the Council of Scientific and Industrial Research, New Delhi.

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PENICILLIN TREATMENT OF SYPHILIS

By LIEUT.-COLONEL R. R. WILLCOX
Adviser in Venereology to the War Office

A MEETING of the investigators into penicillin treatment of the U.S. National Research Council was held in Washington during February 7–8 under the auspices of the U.S. Public Health Service. The meeting was attended by more than two hundred medical men, and Dr. J. E. Moore, presiding, opened the discussion. He stated that the United States Public Health Service had taken on the organised study of syphilis in January 1946. The present data are up to August 1945, and cover some twenty-six treatment schedules with intramuscular penicillin, varying from 0·06 to 2·4 million units with time ranges of 3½, 7½ and 15 days, and sometimes combined with other agents. Penicillin in oil beeswax has also been studied. More than 10,400 cases have been treated by one of the official schedules. New research schedules were announced.

Dr. N. R. Ingraham (Philadelphia) described the results of treating 79 pregnant women suffering from early symptomatic syphilis and 35 suffering from latent syphilis. From both series there were only three abortions and one child found suffering from congenital syphilis. A success-rate of syphilis prevention of more than 97 per cent was claimed to be unequalled by any other mode of treatment.

Dr. Platou (Tulane University) described 191 cases of congenital syphilis treated at a mean age of 164 days. He concluded that so far sodium penicillin

is the best agent yet employed in the treatment of congenital syphilis.

Dr. Rosahn gave the cumulative observations on early syphilis of the participating clinics as analysed by the Central Statistical Unit of the Johns Hopkins University. He showed by means of charts that: (1) The cumulative percentage of failures varied inversely with the total dosage. (2) The cumulative failure-rate at eleven months with 300,000 units of penicillin alone was twice as great as when combined with 320 mgm. 'Mapharsen'. (3) No sizeable differences were noted if the injections were spaced 3 or 6 hours apart or whether the treatment was continued for 3½ or 7½ days. (4) For long durations of the disease before treatment the failure-rate was higher than for a short time. (5) No difference was noted as between coloured and white races. The female rate was slightly higher than the male. (6) Patients retreated for clinical failure showed a higher cumulative rate failing again than a comparable group of previously untreated secondary syphilis. (7) A comparison of different clinics handling the same schedules showed marked differences in the percentages becoming sero-negative even when laboratory techniques were apparently the same.

Lieut.-Col. T. H. Sternberg gave details of 1,107 Army patients treated with 2·4 million units over 7½ days. Only in 9·5 per cent of cases was the treatment considered to be unsatisfactory, and the speaker believed this was a good treatment. Dr. Evan Thomas (New York), on the other hand, had treated 1,119 patients with 1·2 million units of penicillin given three-hourly over 7½ days plus 0·04 gm. 'Mapharsen' daily for 8 days. Of 611 patients followed there was a failure-rate of 12 per cent at 6 months. With 1·2 million units of penicillin only there was a failure-rate of 17·6 per cent of 556 followed for the same time. Dr. Schoch (Dallas) had treated 291 cases with 1·2 million units of penicillin over 7½ days plus 1 gm. of bismuth subsalicylate in oil. The failure-rate at 160 days was 6 per cent as compared with 10 per cent on the same dose of penicillin alone. Dr. G. X. Schwemlein (Chicago) described 108 patients treated with 1·2 million units of penicillin over 7½ days plus a three-hour fever session of 106° F. (rectal) administered by hypertherm on the second, fourth and sixth days. The patients were observed for 154–353 days and there has been a 14·7 per cent failure-rate to date. A further 202 patients were given a two-day treatment. These patients have been observed 153–361 days and 19·3 per cent of failures have occurred to date.

Capt. J. M. Romansky described his work on penicillin in oil beeswax. 300,000 units per c.c. peanut oil with 4·8 per cent by weight of beeswax is recommended as the optimum strength. Calcium penicillin of 1,000 units per mgm. is essential. Calcium penicillin in oil beeswax maintains potency over a year at room temperatures, but the sodium salt not only produces erratic blood levels but also begins to deteriorate after 3–4 months.

Dr. R. C. Arnold showed results of increasing doses of penicillin given over decreasing periods of time in rabbit syphilis. He concluded that rabbit syphilis could be cured in 12 hours or less and that additional studies should be undertaken with the object of intensifying and shortening the treatment of syphilis patients. Dr. H. Eagle took the opposite view and considered the intensification of the dose a waste of penicillin, as it would be 'thrown away', and considered a second dose after an interval of far more value. He went on to describe his experiments, showing that the effects of 'Mapharsen' and penicillin in rabbit syphilis were synergistic. He stated that with the addition of subcurative doses of 'Mapharsen', the amount of penicillin required to cure rabbit syphilis is reduced to a fraction of that required when penicillin is used alone. He stated, too, that, as arsenic combines with spirochætes, when given over a short period of time the arsenic which is concentrated many times within the spirochæte was equivalent to penicillin given over a long time, as the latter is only effective as long as it remains in the surrounding fluid. Dr. C. M. Carpenter, working on penicillin and fever in rabbit syphilis, found much better results with fever combined with multiple rather than with single injections and considered that the effects of penicillin and fever were additive.

Dr. J. H. Stokes (Philadelphia) described 191 cases of late syphilis observed for more than 120 days and treated with penicillin on two dosage ranges of 1·2–4·8 million units and 4·8–10 million units in from one to four courses. He concluded that penicillin sodium in saline solution is effective to a greater or lesser degree in all aspects of neurosyphilis studied, that its most striking effects are seen in the spinal fluid, and that this good effect extends over weeks and months, though the maximum results are usually seen in the first 120 days. He found that there was no apparent concomitance between the response in the spinal fluid and that in the blood.

Against these and other encouraging reports, Dr. R. R. Kierland (Mayo Clinic), describing 49 cases receiving up to 16 million units, and in some instances fever in addition, concluded that in neurosyphilis, penicillin does not achieve the results that it does in the other forms of the disease.

Within a week of the Washington meeting further important data came to light. Two laboratories working on the various fractions of penicillin in rabbit syphilis found that penicillin *K* was markedly less effective than penicillin *G*. As commercial penicillins recently have contained much more penicillin *K* than was formerly the case, the statistics of the Johns Hopkins Hospital were re-analysed as regards the time factor. It was found that cases treated prior to May 1944 fared much better than those treated after that date. It was concluded that, while this was probably due to the effect of the increasing amounts of penicillin *K* present in the commercial penicillins, the question of the removal of impurities must also be considered.

VISITORS' RESEARCH STATIONS IN THE TROPICS

IN a report to the Pacific Science Conference (Washington, D.C., June 1946), Dr. Frans Verdoorn, editor of *Chronica Botanica*, has directed attention to the desirability of suitable provision being made for biologists who wish to study and make collections in different tropical regions. As an indication of the kind of facilities that might be offered he refers briefly to the International Zoological Station at Naples created by Dohrn. This large and well-equipped station was established, in an area rich in fauna and flora, to afford laboratory, collecting, museum and library facilities to visiting biologists from all parts of the world. The financing of the

Station is on an international basis. "No words," says Verdoorn, "can describe the inspiration, as well as the scientific results, for which the Naples Station may be given credit."

To afford comparable facilities in suitable areas in the tropics Verdoorn makes a plea for the establishment of what he describes as "Visitors' Research Stations". Many will sympathize with him in this aim. The present method whereby visitors make use of facilities already existing, such as the laboratories of botanic gardens, departments of agriculture, etc., has its disadvantages. It is true that, by his personal influence, Treub as director of the Buitenzorg Botanic Gardens in Java and later at Tjibotas created what was in fact an informal, international, biological station, and men of science were attracted to it from all parts of the world. He organised a small, well-equipped laboratory for visitors, and provided adequate but inexpensive living facilities. Verdoorn would, however, prefer to have such facilities on a different footing. Briefly, his model would operate along the following lines. The Visitors' Station would not be informal and dependent; but a more or less independent unit, associated with the existing agricultural or biological institutions. It would consist of a large modern laboratory, equipped for simple research in all branches of biology, physiology, chemistry, etc. It would be provided with a small library of general reference works, for example, literature on local floras, maps, etc., periodicals being consulted in the large libraries of the adjacent institutions. There would be a small 'social building' with a theatre for films, lectures, etc., and, not least important, a modern dormitory and restaurant and a medical annexe, each with its permanent staff.

The laboratory would have a small permanent staff, consisting of a director—"an organiser with international experience and idealism, willing to sacrifice a good part of his own opportunities for research in order to aid and assist others"—and a small number of resident specialists well versed in the local flora, fauna, etc., and therefore capable of directing visitors to the materials which they might require in their work.

The aims of such a station would be, broadly speaking, to promote scientific research in the tropics and to develop interest in biological science at all levels of specialization against the tropical background. As to why these things should be done, Verdoorn gives several reasons. Access by biologists to tropical materials, and personal experience of tropical conditions, are of themselves of great importance. But Verdoorn gives another reason of great practical importance at the present time, and possibly for decades to come. "Except in times of worldwide economic depression, it is difficult to get even fair numbers of first-class scientists to do research and experiment station work for the majority of the tropical countries. It has always been so and will remain so in most countries, whatever progress is made in travel, medicine, refrigeration, and local education. For the development and reconstruction of the larger tropical areas a great number of scientists are needed. They must be good scientists, not men who come merely because they cannot succeed elsewhere." This is absolutely correct and sound. No one with recent experience of agriculture, and biological science generally, in the tropics, whether of the Old World or of the New, will challenge this statement. There have been too few good biologists in the tropics in the past: the personnel situation is still more aggravated at the present time while the problems have gained in magnitude.

On the location of the visitors' research stations, Verdoorn is explicit: they will be developed in proximity to existing institutions, for example, at Buitenzorg, Calcutta, Peradeniya, Manila, etc. There should, of course, be a close and sympathetic understanding between the visitors' station and the existing institutions.

Lastly, while the general argument has been developed in terms of the biological sciences, the field of work could be extended to all scientific subjects where field-work is important. The method of procedure for the development and financing of such stations has yet to be worked out. Whatever the system eventually adopted may be, biologists have reason to be grateful to Dr. Verdoorn for his timely emphasis of the fact that facilities for tropical study should be provided on an international basis as soon as possible in the general interest.

MEASUREMENT OF VISCOSITY

A MEETING of the British Rheologists' Club was held on June 15 at the National Physical Laboratory, Teddington, by courtesy of the director, when Dr. Guy Barr spoke on recent developments in viscometry, including the calibration and design of standard viscometers.

After giving a survey of early ideas on viscosity leading to Maxwell's definition of dynamic viscosity, Dr. Barr stressed the importance of kinematic viscosity, which came into importance later because of its application in hydraulics and especially in aerodynamics. Until 1913, no name was attached to the unit of viscosity; Deeley and Parr then suggested the word 'poise' (from Poiseuille) for η, the unit of dynamic viscosity; and later, in 1928, Jakob proposed the word 'stoke' (from Stokes) for ν, the unit of kinematic viscosity; $\nu = \eta/\sigma$ where σ is the density of the liquid. These names and their derivations, namely, centipoise (cp.) and centistoke, have been universally adopted. The poise has the dimensions $ML^{-1}T^{-1}$, and is correctly expressed as grams/cm./sec., whereas the stoke has the dimensions L^2T^{-1}, that of a diffusion of momentum.

Dr. Barr pointed out that the Ostwald, and U-type viscometers in general, are subject to small errors if not placed strictly vertical, and modifications of their design to minimize the error have been made by Gruneisen, Fenske, Ubbelohde, and others; these modifications are much in use with petroleum products. Fenske places the reservoirs one above the other and Ubbelohde in his suspended level viscometer does not require any particular quantity of liquid. Small discrepancies in results obtained with carefully calibrated standard viscometers by observers in different laboratories (joint meeting of Institute of Petroleum and British Rheologists' Club, *J. Inst. Pet.*, **31**, 260; 1945) cannot be attributed to gravity variations, observational errors, or lack of temperature control, etc., but appear to be due to differences of surface tension in the standard liquids used for calibration. With water and sugar solutions, the surface tensions and contact angles are considerably higher than with the petroleum oil standard calibrating liquids. Dr. Barr described experiments illustrating the effect of surface tension on the flow

of liquids in viscometers, and exhibited viscometers designed to eliminate the surface tension difficulty.

On the subject of the measurement of viscosity of non-Newtonian liquids, Dr. K. Weissenberg mentioned the method of making the liquid system vibrate and observing the wave motion. The meeting discussed the use of the falling sphere method; Dr. E. Mardles pointed out that the rate of fall of a sphere through paints and greases varies considerably with depth, and often the sphere remains suspended, a finding confirmed by Dr. Barr, who with an unusual sample of tar and using X-ray photography found that the ball remained practically suspended before reaching the bottom. Dr. Mardles has obtained more promising results by using a thin plate drawn through the system, the rate of movement being nearly constant through the bulk. By varying the weight attached to the fine thread over a light pulley pulling the plate, it is possible to determine the yield value (see *Nature*, August 10, p. 199).

Those present visited departments where investigations of a rheological character were in progress; these included the silting of harbours, the slow creep of metals, the ventilation of buildings, plastics, use of strain gauges, etc.

UTILIZATION OF AFRICAN FOREST WOODS

WAR production forms the main theme of the annual reports of some of the African forest services—the demands for timber and wild rubber production, the latter due to the disappearance of the Malayan supplies. In the report for 1943 from Nigeria (Govt. Printers, Lagos, 1944) it is stated that military demands for timber revived, while the projected relaying of the railway line between Jebba and Minna required over a period of three years 300,000 sleepers. It was hoped to supply a high proportion of these from the Kurmis of the northern provinces, from *Khaya senegalensis* and *grandifoliola*. Trouble was experienced from warping and cracking due to an exceptionally severe harmattan; an exacting specification impossible for pit-sawyers to fulfil and other difficulties were experienced. These resulted in a high percentage of rejects, so the work of supplying is to be transferred to the southern provinces, although this involves long haulages by rail. Besides this railway contract, of which a portion was cut, 333,358 cu. ft. were produced for military use; 1,455,730 cu. ft. for local consumption; 40,924 cu. ft. from the mines, and 2,038,592 cu. ft. by logs and timber cut for export. This latter went to the United Kingdom, United States, South Africa, other parts of West Africa and French West Africa. One notable result of this increased war demand for timber, especially sawn timber required by the military, is the substantial and growing local demand by the African for this last type of material, which should, in the future, result in far better housing conditions for the population.

In the report for 1943–44 from the Gold Coast (Govt. Printing Department, Accra, 1944) timber and rubber production appear to have proved the chief preoccupations of the Department. Apart from the pit-sawn timber used locally, the pit-sawn timber supplies handled by the Department through its numerous subcontractors totalled 1,060,000 cu. ft. This was supplied to the British Services, United States Army, Government Departments, etc. 133,000 pit-sawn sleepers required for an extension of the Gold Coast Railway and demanded at short notice were included in the above. One outcome of the military demand was the making of furniture in the Colony, a woodworkers' company having been started in Accra. Here again this may lead to the adoption of better types of furniture in the houses of the Africans in the future. In the Gold Coast, as in India and other parts of the Empire, the demand for tool handles was met by local production, and cutlass handles, and handles for felling axes, pick axes, shovels, hoes, rakes and all kinds of hammers were prepared from local woods; as also shingles for roofing.

The annual report for 1944 for Uganda (Government Printing Department, Uganda, 1945) says that the demand for timber for operational use by the military became more pressing and everything possible was done to increase output by opening up new areas and arranging for the circulation and extension of sawmills. The nine firms working exclusive licences operated twelve mills and produced 32,873 tons of 50 cu. ft. of sawn timber each, plus 746 tons of export logs. Eleven other firms with twelve mills turned out 7,541 tons of sawn timber, while pit-sawyers produced 3,835 tons. This timber came from the crown lands, crown forests and private forest (about one sixth only). 79 per cent of the total went to the military, 8½ per cent to the civil governments, and the balance to the public. Exports were 749 tons of logs and 39,148 tons of sawn timber, including 126,395 sleepers. The report gives interesting information on the wild rubber collection, which has absorbed a proportion of the staff of all the Departments. "The Wild Rubber section collected 25·75 tons of dry *Funtumia* rubber in Bunyoro and private enterprise 8·04 tons in the Mabira Forest, while in Buganda the Department bought 3·13 tons of vine rubber and private enterprise 2·47 tons. All possible *Funtumia* trees have been severely tapped twice in two years and are exhausted, so tapping was stopped at the end of the year."

It is to be hoped that all the Departments, now that war-time demands have ceased, will undertake a careful inventory of their exploited forests, so as to bring to an end any further overfelling where such has occurred.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN FRUIT AND VEGETABLES—The Principal, Midland Agricultural College, Sutton Bonington, Loughborough (August 24).

ASSISTANT LECTURER IN CHEMISTRY, preferably with qualification in Pharmaceutical Chemistry, in the Bradford Technical College—The Director of Education, Town Hall, Bradford (August 24).

LECTURER IN CHEMISTRY in the Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (August 24).

LECTURERS (2) ON MINING SUBJECTS at the Coalville Mining and Technical Institute—The Director of Education, County Offices, Grey Friars, Leicester (August 30).

ENTOMOLOGIST, ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF ZOOLOGY AND COMPARATIVE ANATOMY, and an ASSISTANT LECTURER IN EXPERIMENTAL ZOOLOGY—The Registrar, University College, Cathays Park, Cardiff (August 31).

INSTRUMENT MAKER FOR PHYSICS WORKSHOP—The Head of the Physics and Mathematics Department, Central Technical College, Suffolk Street, Birmingham 1 (August 31).

ASSISTANT LECTURER (man or woman) IN BIOLOGY in the Bradford Technical College—The Director of Education, Town Hall, Bradford (August 31).

ASSISTANT LECTURER OF LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, University College, Hull (August 31).

CIVIL ENGINEER (MAINTENANCE) in the Department of the Civil Engineer—The Chief Staff and Welfare Officer (reference E.R./E.250), London Passenger Transport Board, 55 Broadway, London, S.W.1 (August 31).

DIRECTOR OF THE DEPARTMENT OF SCIENTIFIC AND TECHNICAL LIAISON OF THE INTERNATIONAL WOOL SECRETARIAT—The Secretary, International Wool Secretariat, Grand Buildings, Trafalgar Square, London, W.C.2 (August 31).

ASSISTANT LECTURER AND DEMONSTRATOR IN BOTANY, with special preference for Plant Pathology or Genetics—The Registrar, University College, Cathays Park, Cardiff (August 31).

LECTURER (man or woman) IN PHARMACEUTICAL SUBJECTS at the Plymouth and Devonport Technical College—The Director of Education, Education Offices, Cobourg Street, Plymouth (August 31).

ASSISTANT LECTURERS (2) IN GEOLOGY—The Registrar, The University, Manchester 13 (August 31).

ASSISTANT LECTURER IN APPLIED CHEMISTRY—The Registrar, College of Technology, Manchester 1 (August 31).

LECTURER IN PHYSIOLOGY—The Registrar, Technical College, Sunderland, Co. Durham (August 31).

RESEARCH ASSISTANTS (2), one for work in LAND UTILISATION and one for work in AGRICULTURAL STATISTICS—The Professor of Agricultural Economics, University of Reading, 7 Redlands Road, Reading (August 31).

ENGINEERING INSPECTORS (12)—The Establishment Officer, Ministry of Health, Whitehall, London, S.W.1 (from the United Kingdom, August 31 : from Overseas, September 28).

LECTURER IN CHEMISTRY, a LECTURER IN THE NATURAL SCIENCE DEPARTMENT, a LECTURER IN CIVIL ENGINEERING, a LECTURER IN NATURAL SCIENCE DEPARTMENT with Honours Degree in Botany, a LECTURER IN CHEMISTRY, a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Principal, Derby Technical College, Normanton Road, Derby (September 1).

PRINCIPAL RESEARCH OFFICER or SENIOR OFFICER (PHYSICIST) in the Atomic Research Laboratory, University of Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 919 (September 2).

OFFICER-IN-CHARGE, CONCRETE RESEARCH, Building Materials Research Section, Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, quoting Appointment No. 802 (September 2).

LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, The University, Aberdeen (September 6).

JUNIOR LECTURER OF LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (September 7).

CURATOR OF THE ROYAL BOTANIC GARDENS, TRINIDAD—The Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, quoting G.286 (September 7).

TEACHER OF SCIENTIFIC INSTRUMENT CONSTRUCTION AND DESIGN at the South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, London, S.E.1 (September 14).

HEAD OF THE DAIRY HUSBANDRY DEPARTMENT—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (September 15).

SENIOR LECTURER (ungraded) IN THE DEPARTMENT OF PATHOLOGY—The Registrar, The University, Liverpool (September 16).

LECTURER IN ELECTRICAL ENGINEERING—The Secretary, King's College, Strand, London, W.C.2 (September 16).

PROFESSOR OF ENGINEERING—The Registrar, University College, Singleton Park, Swansea (September 21).

LECTURER (ungraded) IN THE DEPARTMENT OF PATHOLOGY—The Registrar, The University, Liverpool (September 23).

METEOROLOGICAL OFFICERS IN THE COLONIAL SERVICE :—(*a*) Officers (4), Malayan Meteorological Service ; (*b*) Assistant Director, Observatory, Mauritius ; (*c*) Professional Assistants (2), Royal Observatory, Hong Kong—The Director of Recruitment, 15 Victoria Street, London, S.W.1 (October 5).

LECTURER and an ASSISTANT LECTURER IN CIVIL OR MECHANICAL ENGINEERING—The Registrar, University College, Nottingham.

ASSISTANT IN EACH OF THE DEPARTMENTS OF LOGIC AND MORAL PHILOSOPHY—The Secretary, The University, Aberdeen.

GRADUATE IN CHEMISTRY OR PHYSICS for the Intelligence Division and Library—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

SENIOR LABORATORY ASSISTANT to take charge of the chemical stores, maintenance of the chemistry and physics laboratories and repair of glass apparatus—The Principal, Medway Technical College, Gillingham, Kent.

LECTURER IN GEOLOGY—The Principal, Kingston Technical College, Kingston-upon-Thames, Surrey.

ASSISTANT TECHNICIAN IN PHYSICS DEPARTMENT—The Secretary, Mount Vernon Hospital, Northwood, Middlesex.

RESEARCH PHYSICIST for work on vacuum spectroscopy—Prof. Ditchburn, c/o Registrar, The University, Reading.

LABORATORY ASSISTANT (Grade I) FOR THE PHYSIOLOGY DEPARTMENT—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

LECTURER IN PHYSICAL AND ENGINEERING METALLURGY, preferably with experience in Mechanical Treatment and Welding—The Secretary, Imperial College of Science, South Kensington, London, S.W.7.

HONOURS GRADUATE (male) with previous research experience in chemistry or physics for fundamental investigations in the properties of rubber-like polymers—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

TECHNICAL ASSISTANT IN THE DEPARTMENT OF PLANT PHYSIOLOGY—The Registrar, Queen Mary College, Mile End Road, London, E.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Science in Post-Primary Education, with reference to the Scientific Education in Schools of Pupils of 11–18, and its relation to their Subsequent Training in Universities and Colleges. Second Part of the Report of a Sub-Committee of the Association of Women Science Teachers. Pp. vi+57. (London : John Murray, 1946.) 2*s.* [1

Europe : Selected Climatic Factors relevant to Structural and Insulation Requirements for Houses. Notes and Maps prepared by the Research Maps Office, Ministry of Town and Country Planning for the Inter-Allied Committee for Physical Planning and Reconstruction. Pp. ii+8+10 maps. (London : Ministry of Town and Country Planning, 1946.) [1

British Rubber Producers' Research Association. Publication No. 65 : Contributions to Symposium on Breakdown of Rubber. i. Oxidative Breakdown of Rubber, by E. H. Farmer ; ii. Photochemical Breakdown of Rubber, by L. Bateman ; iii. Thermal Breakdown of Rubber, by J. L. Bolland and W. J. C. Orr. Pp. 24. (London : British Rubber Producers' Research Association, 1946.) [1

A Scheme for Recording the Potency of Carcinogenic Agents. Proposed by J. F. Moseley. Pp. 20. (Altrincham : J. F. Moseley, Cancer Research Laboratory, 1946.) 2*s.* 6*d.* [1

The Prophets of Peckham : a Message for the Times. By W. Margrie. Pp. 40. (London : The Author, 24 Nigel Road, S.E.15, 1946.) 1*s.* [1

Other Countries

Annuaire astronomique de l'URSS pour l'an 1946. Vingt cinquième année. (In Russian.) Pp. 438. (Moscow and Leningrad : Akademii Nauk SSR., 1946.) 75 rub. [2

Meddelanden från Oceanografiska Institutet i Göteborg. 8 : On Anti-Rachitic Ultra-Violet Radiation in the Sea. By Nils G. Johnson. Pp. 16. 9 : Some Culture Experiments with Marine Plankton Diatoms. By Tore Levring. Pp. 18. (Göteborg : Elanders Boktryckeri A.-B., 1945–1946.) [3

Publications of the Isostatic Institute of the International Association of Geodesy. No. 14 : Gravity Formulas derived by the Aid of the Level Land Stations. By E. Niskanen. Pp. 16. (Helsinki : International Association of Geodesy, 1945.) [3

South Australia : Department of Mines. Mining Review for the Half-Year ended 30th June 1944. (No. 80.) Pp. 118. (Adelaide : Government Printer, 1945.) [3

Carnegie Institution of Washington. Publication 557 : Contributions to Embryology, Vol. 31, Nos. 198–206. Pp. 175 + 45 plates. (Washington, D.C. : Carnegie Institution, 1945.) 4.50 dollars. [5

Carnegie Institution of Washington. Publication 563 : Cambrian History of the Grand Canyon Region. Part 1 : Stratigraphy and Ecology of the Grand Canyon Cambrian, by Edwin D. McKee ; Part 2 : Cambrian Fossils of the Grand Canyon, by Charles E. Resser. Pp. viii + 232. (Washington, D.C. : Carnegie Institution, 1945.) 2.50 dollars. [5

State of California, Department of Natural Resources : Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 61 : Result of Tagging Experiments in California Waters on the Sardine (*Sardinops caerulea*). Pp. 90. Fish Bulletin No. 62 : Catch per-Unit-of-Effort in California Waters of the Sardine (*Sardinops caerulea*), 1932–1942. By Ralph P. Silliman and Frances N. Clark. Pp. 76. (Terminal Island, Calif. : California State Fisheries Laboratory, 1945.) [5

Cornell University : Agricultural Experiment Station. Bulletin 813 : Studies on Storage Scald of Apples. By R. M. Smock and F. W. Southwick. Pp. 39. Bulletin 815 : Fruit and Vegetable Stores as Retail Outlets for Fruit. By Marius P. Rasmussen, Ford A. Quitaland and Edwin W. Cake. Pp. 68. Bulletin 816 : Consumer Demand for Meat, Syracuse, New York, 1942. By Roice H. Anderson. Pp. 40. Bulletin 817 : Sodium Nitrate as a Supplement to Farm Manure and Red Clover. By J. A. Bizzell and E. W. Leland. Pp. 8. Bulletin 818 : The Cost of Producing Milk, 1942–43. By L. C. Cunningham. Pp. 14. Bulletin 820 : Hucksters and Pushcart Operators as Retailers of Fruit. By M. P. Rasmussen, F. A. Quitslund and E. W. Cake. Pp. 50. Bulletin 822 : Spacing Affects Yield of Asparagus. By H. C. Thompson. Pp. 8. Bulletin 823 : Pasture Experiments with Growing Pullets. By G. F. Heuser, L. C. Norris and J. H. Bruckner. Pp. 22. (Ithaca, N.Y. : Cornell University, 1945.) [5

Cornell University : Agricultural Experiment Station. Memoir 263 : The Rust of Greenhouse-grown Spearmint and its Control. By J. S. Niederhauser. Pp. 30. Memoir 267 : The Symbiotic Performance of Isolates from Soybean with species of Crotalaria and certain other Plants. By J. K. Wilson. Pp. 20. Memoir 268 : The Common Leaf Rust of Cultivated Roses, caused by *Phragmidium Mucronatum* (Fr.) Schlecht. By Vincent W. Cochrane. Pp. 40. Memoir 269 : The Elateridæ of New York State. By Henry Dietrich. Pp. 80. Memoir 270 : The Internal Morphology of the Common Red Spider Mite (*Tetranychus telarius* Linn.). By William Ernest Blauvelt. Pp. 35 + 11 plates. Memoir 271 : Destruction of certain Vitamins and Pigments by Nitrous Acid. By J. K. Wilson. Pp. 6. (Ithaca, N.Y. : Cornell University, 1945.) [5

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